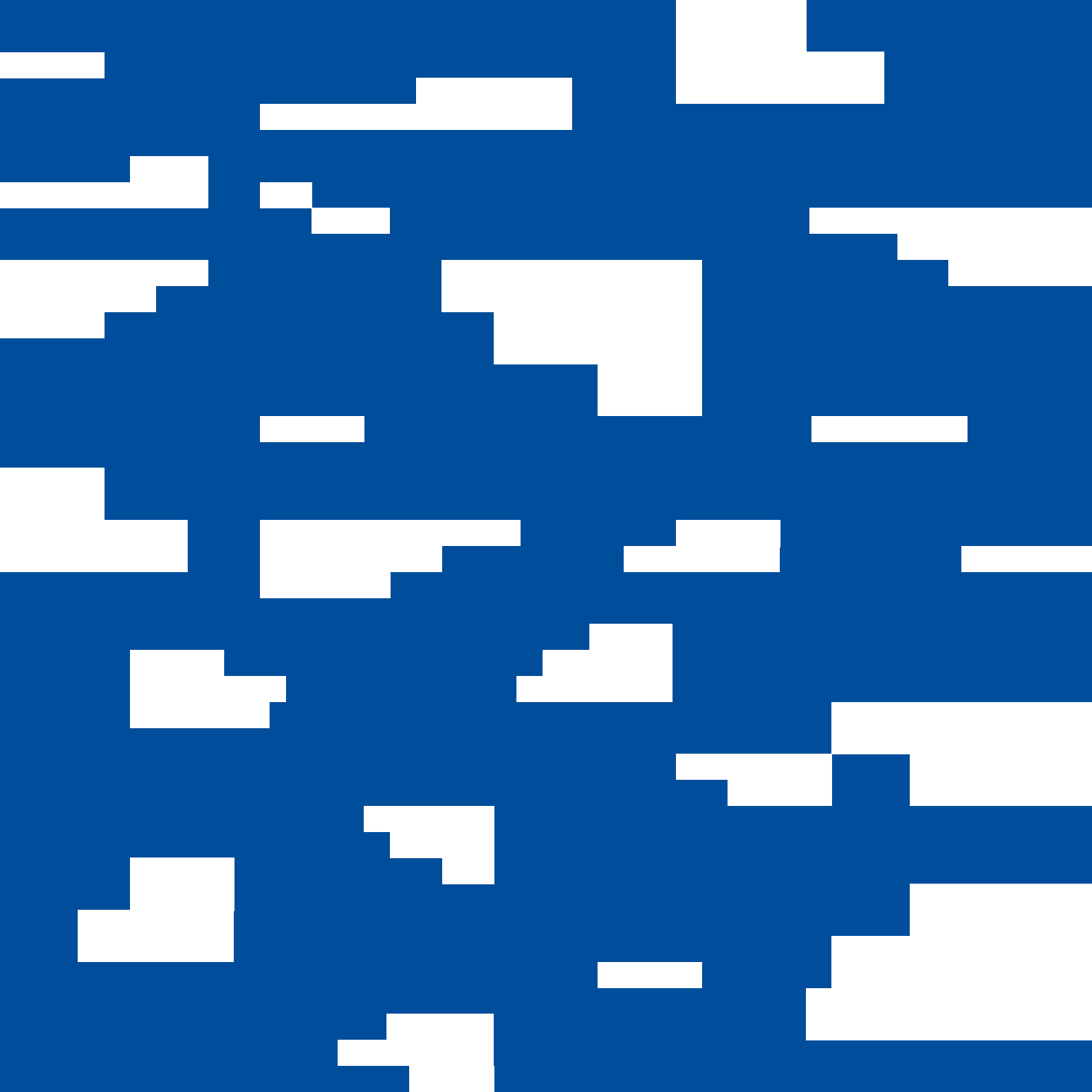
BRNO UNIVERSITY OF TECHNOLOGY

FACULTY OF ELECTRICAL ENGINEERING AND COMMUNICATION

# ANNUAL REPORT 2021



FACULTY OF ELECTRICAL ENGINEERING AND COMMUNICATION

# ANNUAL REPORT 2021

# CONTENT

# OPENING WORD OF THE DEAN

## Dear readers,

Unfortunately, all year 2021 was again impacted by the Coronavirus disease and we were flooded with numbers of infected, tested, vaccinated or unvaccinated, ill or recovered people. We were studying continuously all the emerging epidemic measures. I wish to all of us that in the following year the new measures were less chaotic and illogical and we could get rid of the unpopular masks and respirators.

In the first half of 2021 we were forced to shift to online teaching and studying and I would like to thank to all students for their patience and determination to overcome obstacles caused by such type of study. Moreover, I would like to express my gratitude to all teachers for their extraordinary work commitment which they exercised in their lessons and were helpful to students in solving problems caused by epidemic measures and regulations. I am extremely pleased that 2021 winter semester enabled attended form of teaching. Perhaps, last year taught us to be more grateful for students attending lessons, which cannot be replaced by any advanced communication software, and to realize that working relationships cannot be kept online ad nauseam.

I personally appreciated that last year we could organize graduation ceremonies at least in their reduced form and for master students only. Despite great limitations and obstacles in organising social events our students from SPS were able to organize Music from FEEC contest with historical record attendance, which I admire greatly. I also highly praise employees and students who were helping South Moravia region after the devastating tornado. They proved to be extraordinary personalities who are capable of  helping society in facing unexpected challenges.

Last December the faculty elected a new Dean. I highly appreciate the trust I was expressed in December elections by the faculty academic senate. In my second functional period I would like to focus on further development of the prestigious and dynamically evolving faculty.

Nowadays, Faculty of Electrical Engineering and Communication ranks to highly recognized educational institutions in the Czech Republic and elsewhere thanks to its vast range of study programmes, excellent laboratories and scientific results.

The development of the faculty is, however, closely related to work enthusiasm of the people working there. I would like to thank again to all employees and students for their work and study results at our faculty in a difficult 2021 year.



**prof. RNDr. Vladimír Aubrecht, CSc.**
Dean

Photo: Jana Valchová

# MISSION, VISION AND STRATEGIC GOALS OF THE FACULTY

Faculty mission is to raise university experts with complex knowledge and skills in accredited study programmes, to develop a good quality scientific research at national and international level and to produce creative activity results highly relevant for further research and social impact.

Photo: Jakub Rozboud

F

**Faculty**

is an excellent educational institution preparing graduates ready to participate in the dynamical development of advanced technologies. Thanks to close faculty cooperation with the industry a vast majority of students finds their job even before the study completion.

E

**Excellent**

scientific research is conducted not only at individual faculty departments, but also at two regional research centres SIX and CVVOZE. The faculty also takes part in the activities of the CEITEC BUT scientific research centre of excellence. Our scientific research is focused on vast range of projects affecting not only everyday life, but forming also our future, such as the development of Parkinson disease early diagnosis tool, secure cyberspace or the Smart Cities project.

E

## Engineering

Tradition of the faculty can be traced to the first half of the last century. For sixty years the faculty has been developping educational and research activities in electrotechnics, electronics and related fields. It was founded in 1959 by the governmental Act No. 59 dividing the Faculty of Energy into Faculty of Mechanical Engineering and Faculty of Electrical Engineering. Since 12 August 1959 the faculty has been acting independently.

C

## Campus

of the Faculty of Electrical Engineering and Communication is situated in Brno-Královo Pole. The construction of the modern educational and research complex was completed in 2013 and after more than 50 years of faculty existence it enabled to unite all faculty workplaces into one place located Pod Palackého vrchem.

## 2021 FEEC Facts in Numbers

**3,132**
students

**1,079**
opened subjects

**180+**
solved projects

**486**
publications

**72**
prototypes, software or functioning samples

**9**
successfully completed habilitations and appointments

**558**
employees

**9**
international conferences (co) organized by the faculty

# FEEC EMPLOYEES

## Faculty of Electrical Engineering and Communication (FEEC) Management

**Dean**
prof. RNDr. Vladimír Aubrecht, CSc.

**Vice-Dean for Study Affairs, statutary representative of the Dean**
prof. Ing. Jarmila Dědková, CSc.

**Vice-Dean for Development and Strategic Planning**
doc. Ing. Petr Fiedler, Ph.D.

**Vice-Dean for International and Public Relations**
doc. Ing. Jiří Háze, Ph.D.

**Vice-Dean for Research and PhD study**
prof. Ing. Jaroslav Koton, Ph.D.

**Financial officer**
Ing. Miloslav Morda

# Organisational Structure

## DEAN'S OFFICE

- Organising Department
  - Library
- Student Affairs Department
- Department of Science and International Relations
- Personnel and Legal Department
- Accounting and Finance Department
- Information Systems Administration Department
- Branch Facilities Management Technická

## ACADEMIC SENATE

Chairman

- doc. Ing. Miloslav Steinbauer, Ph.D.

## ACADEMIC STAFF CHAMBER OF THE SENATE

Chairman

- doc. Ing. Vlasta Sedláková, Ph.D.

## STUDENTS' CHAMBER OF THE SENATE

Chairman of the Chamber

- Ing. Daniel Janík

## SCIENTIFIC BOARD

Chairman

- prof. RNDr. Vladimír Aubrecht, CSc.

## STUDY PROGRAMME BOARD

Chairman

- prof. Ing. Jarmila Dědková, CSc.

## DISCIPLINARY COMMITTEE

Chairman

- Ing. Helena Polsterová, CSc.

## ETHICS COMMITTEE

Chairman

- doc. Ing. Jana Kolářová, Ph.D.

## DEPARTMENTS AND RESEARCH CENTERS

- Department of Control and Instrumentation (UAMT)
- Department of Biomedical Engineering (UBMI)
- Department of Electrical Power Engineering (UEEN)
- Department of Electrical and Electronic Technology (UETE)
- Department of Physics (UFYZ)
- Department of Foreign Languages (UJAZ)
- Department of Mathematics (UMAT)
- Department of Microelectronics (UMEL)
- Department of Radioengineering (UREL)
- Department of Telecommunications (UTKO)
- Department of Theoretical and Experimental Electrical Engineering (UTEE)
- Department of Power Electrical and Electronic Enginering (UVEE)
- Centre of Research and Utilisation of Renewable Energy Sources (CVVOZE)
- Cenre of Sensor, Information and Communication Systems (SIX)

## OTHER ACTIVITIES

- Trade Unions-ZO 2698
- Club 'Elektron'
- Faculty interactive playroom 'Elektrikárium'
- Multifunctional room for students 'Studentárium'

# Habilitations and Appointments to Professorship

## New FEEC professors appointed by the President of the Czech Republic in 2021

### ELECTRICAL AND ELECTRONIC TECHNOLOGY

- prof. Ing. Jaromír Hubálek, Ph.D.

### TELEINFORMATICS

- prof. Ing. Pavel Rajmic, Ph.D.

### POWER ELECTRICAL AND ELECTRONIC ENGINEERING

- prof. Ing. Jiří Drápela, Ph.D.
- prof. Ing. Petr Toman, Ph.D.

## New associate professors at the FEEC appointed by the BUT Rector in 2021

### ELECTRONICS AND COMMUNICATION

- doc. Ing. Petr Kadlec, Ph.D.

### ELECTRICAL AND ELECTRONIC TECHNOLOGY

- doc. Ing. Dinara Sobola, Ph.D.
- doc. Ing. Vladimír Holcman, Ph.D.
- doc. Ing. et Ing. Vilém Neděla, Ph.D.

### TELEINFORMATICS

- doc. Ing. Pavel Šilhavý, Ph.D.

Photo: Jakub Rozboud

## Number of faculty employees in 2021

| | |
|---|---|
| Number of faculty employees: | 558 (425.62 recalculated number) |
| Number of academic and scientific staff: | 302 (233.5 recalculated number) |
| Average age of FEEC employees: | 43.2 years (as of 31. 12. 2021) |
| Ratio of women employees at FEEC: | 26.4 % (as of 31. 1. 2021) |

# STUDY AT FEEC

The faculty offers a complex range of study programmes focused on electronics, electrical technology and all related fields from microelectronics, telecommunications, cybernetics and power engineering to interdisciplinary studies such as biomedicine and audio engineering. It offers 14 three-year bachelor study programmes, 26 two-year master study programmes and 31 four-year doctoral study programmes. We are a faculty with the widest range of electrical engineering study programmes, both in attended as well as combined form of study, in Czech and English. With more than 3,000 students, we are the largest electrical engineering faculty in both the Czech and Slovak Republics.

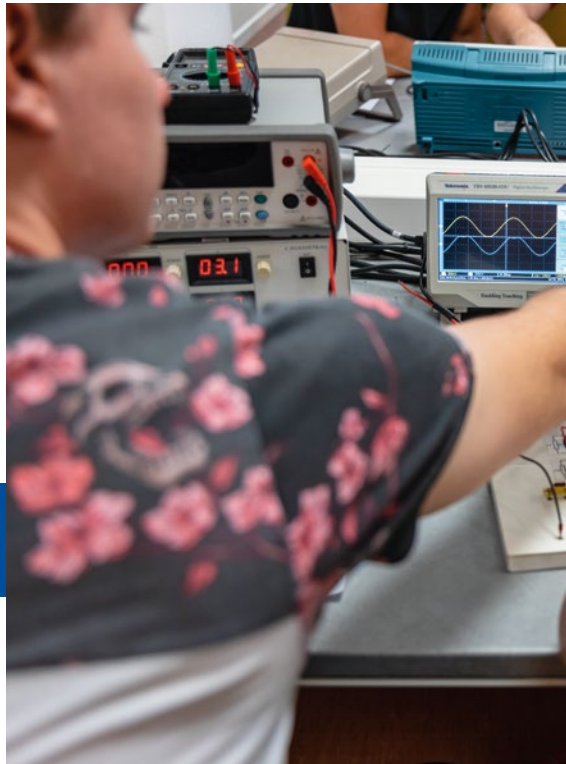


Photo: Jakub Rozboud

## Excellent premises

Since 2013, the Faculty of Electrical Engineering and Communication has been situated in the newly constructed and modernly equipped campus area Pod Palackým vrchem. After more than 50 years it compounds the background for both instruction and students life, where students can enjoy both advanced technologies, perfectly equipped laboratories, lecture halls, canteens and libraries together with places for relaxation and sports.

## Practical skills and job perspective of the graduates

Thanks to faculty's cooperation with commercial subjects and industrial partners students can enjoy not only an excellent theoretical preparation, but it also gives them opportunity to try out their practical skills in real life, which is crucial for their future job career. Based on current graduates' poll, 77 % of FEEC students secure their job positions during their studies. 97 % of graduates finds their job within 3 months after their successful completion of studies. These are the best results of all BUT faculties, which shows how successful our students are at the job mark.

Photo: Jakub Rozboud

## FEEC graduates have the highest starting salary at the BUT

Our students are very attractive for employers at the work market and their starting salary is one of the best out of the whole BUT. An average gross starting salary of a fresh FEEC graduate from 2017–2018 is 33,427 CZK.

## Instruction focusing on study programmes innovation

The offer of study programmes as well as the content of the instruction itself undergoes constant innovation. The faculty thus reacts to trends in the industrial sector so that our graduates were absolutely competitive and they could easily find a job now as well as in the future. This is enabled by great experience of our co-workers from various research projects with industrial partners who apply their knowledge and practical skills into instruction.

# Study programmes

## Bachelor studies

**Attended form:**

- English in Electrical Engineering and Information Technology (CZ)
- Audio engineering – Acoustics and Audiovisual Technology (CZ)
- Audio engineering – Sound Production and Recording (CZ)
- Automation and Measurement (CZ)
- Biomedical Technology and Bioinformatics (CZ)
- Electronics and Communication Technologies (CZ)
- Information Security (CZ)
- Microelectronics and Technology (CZ)
- Power Electrical and Electronic Engineering (CZ)
- Telecommunication and Information Systems (CZ)
- Electrical Engineering – Electronics and Communication Technologies (EN)
- Electrical Engineering – Power Systems and Automation (EN)

**Combined form:**

- Electronics and Communication Technologies (CZ)
- Microelectronics and Technology (CZ)
- Power Electrical and Electronic Engineering (CZ)
- Telecommunication and Information Systems (CZ)

## Master studies

**Attended form:**

- Audio engineering – Acoustics and Audiovisual Technology (CZ)
- Audio engineering – Sound Production and Recording (CZ)
- Bioengineering (CZ)
- Biomedical Engineering and Bioinformatics (CZ)
- Electrical Power Engineering (CZ)
- Electrical Power Engineering and Communication Technologies (CZ)
- Electronics and Communication Technologies (CZ)
- Electrotechnical Manufacturing and Management (CZ)
- Information Security (CZ)
- Cybernetics, Control and Management (CZ)
- Microelectronics (CZ)
- Power Electrical Engineering and Electronics (CZ)
- Telecommunications and Information Technology (CZ)
- Bioengineering (EN)
- Communications and Networking (EN)
- Electrical Power Engineering (EN)
- Microelectronics (EN)
- Power Systems and Communication Technology (EN)
- Telecommunications (EN)

**Combined form:**

- Electrical Power Engineering (CZ)
- Electronics and Communication Technologies (CZ)
- Electrotechnical Manufacturing and Management (CZ)
- Power Electrical Engineering and Electronics (CZ)
- Telecommunications and Information Technology (CZ)

Photo: Jakub Rozboud

## Doctoral studies

**Attended form:**

- Electronics and Communications (CZ)
- Information Security (CZ)
- Cybernetics, Control and Management (CZ)
- Microelectronics and Technology (CZ)
- Power Systems and Power Electronics (CZ)
- Teleinformatics (CZ)
- Theoretical Electrical Engineering (CZ)
- Biomedical Technology and Bioinformatics (CZ)
- Biomedical Technologies and Bioinformatics (EN)
- Cybernetics, Control and Measurements (EN)
- Electronics and Communication Technologies (EN)
- Electronics and Information Technologies (EN)
- Microelectronics and Technology (EN)
- Power Systems and Power Electronics (EN)
- Teleinformatics (EN)
- Theoretical Electrical Engineering (EN)

**Combined form:**

- Electronics and Communication Technologies (CZ)
- Information Security (CZ)
- Cybernetics, Control and Measurement (CZ)
- Microelectronics and Technology (CZ)
- Power Systems and Power Electronics (CZ)
- Teleinformatics (CZ)
- Theoretical Electrical Engineering (CZ)
- Biomedical Engineering and Bioinformatics (CZ)
- Biomedical Technologies and Bioinformatics (EN)
- Cybernetics, Control and Measurements (EN)
- Electronics and Communication Technologies (EN)
- Microelectronics and Technology (EN)
- Power Systems and Power Electronics (EN)
- Teleinformatics (EN)
- Theoretical Electrical Engineering (EN)

## Number of students

(Sum total 3,132)

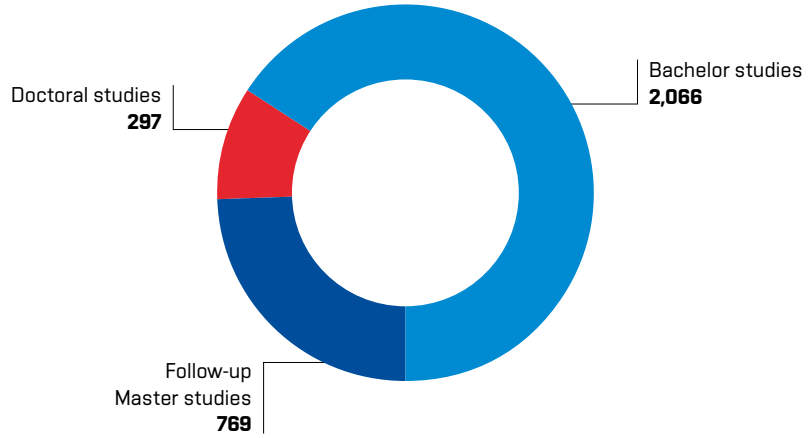
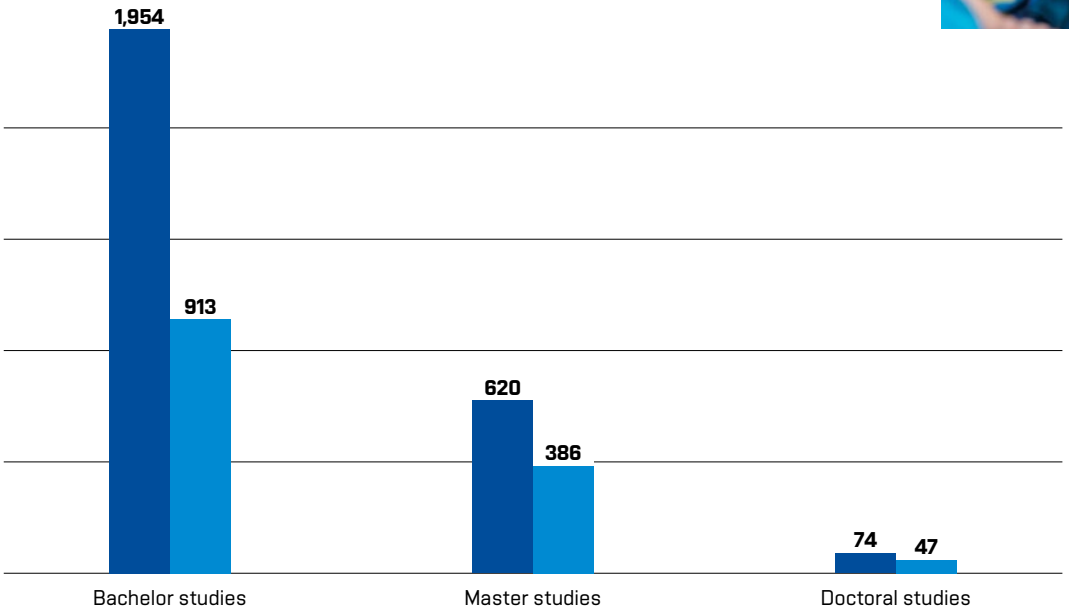



Photo: Jakub Rozboud

## Interest in study




Number of applications

Number of registered students

## ‘Students for Students’ Club

‘Students for Students’ Club has been an inherent part of the FEEC for 16 years. The Club helps new students, it organizes various events for all students and it also works as an intermediary in communication between students and the faculty management.

One of the most valued Club’s activities is the ‘Fresher’s guide’ bulletin which contains everything important for a successful study start not only at the FEEC, but also at other faculties. All events organized by the Club are free for all BUT students, which is the main goal of the Club.

Well-known event organized by the Club is the Hudba z Fektu (Music from the FEEC) which has become almost legendary over the time and all students and graduates are looking forward to it. Recent 13$^{th}$ year was very successful, due to a record attendance. Despite epidemic measures which made the organisation difficult the SPS again succeeded in joining music with technology successfully.

Last year the SPS spent most of its time by fighting COVID-19, but this year, thanks to great enthusiasm and good will of the SPS members, its activities came back to normal before pandemic. Since the beginning of winter semester 2021 the SPS organizes again many cultural and educational activities for BUT students.

Photo: Jakub Brandejs


## Selected event organized by the 'Students for Students' club:

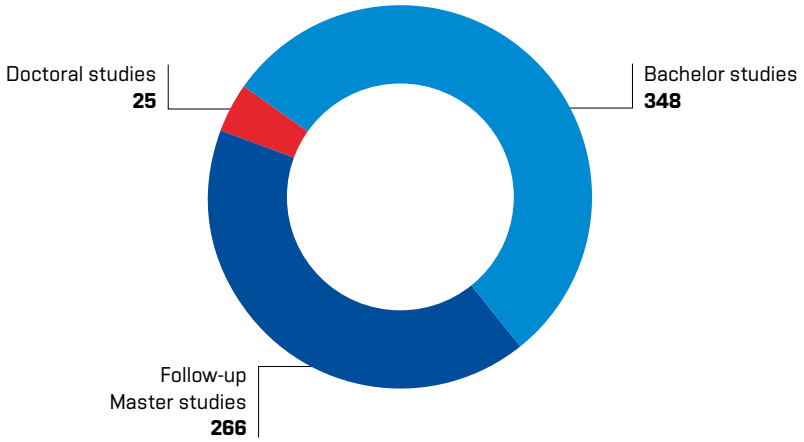
- PerFEKT Start
- Music from FEEC (Hudba z FEKTu)
- Run to 53
- Board Games Days
- Beer run


Photo: Jakub Rozboud

# Graduates

## Number of graduates in 2021

(Sum total 639)




FEEC graduates are very attractive at the job market. They can work in a wide range of professions and fields, e.g. experts in advanced or managerial positions in power electrical engineering, electronics, robotics and applied informatics, as well as in manufacturing and controlling medical technology, cybernetics diagnostics and natural environment protection as engineers in electronics.

# WELL-KNOWN FIGURES

## Well-known students

### Veronika Kamenská, a student of biomedicine, is the youngest talent in Forbes 30 under 30

This year, inspirational thirty Czech talents in business, startups, science, sports and arts include Veronika Kamenská, a FEEC student. She was selected by the Forbes magazine in 30 under 30 list of young and successful personalities, published every year. A twenty-one- year old student from the Department of Biomedical Engineering is the youngest in this year's list. Veronika Kamenská suffered from a mental disorder and based on her own experience she decided to make an application 'Don't panic!' helping people with anxiety or suicidal thoughts. A couple of years ago Veronika was thinking about making an application supporting people with a mental disorder, as, at that time, she suffered from a posttraumatic stress disorder evolving into anxiety and depression. "I was looking for something that would help me in such states. However, all mobile applications were in English and there were no contacts for help in the Czech Republic. Moreover, they were solely focused on either depression, panic or anxiety. But, these disorders are usually interconnected," says the student who decided to destigmatise mental disorders.

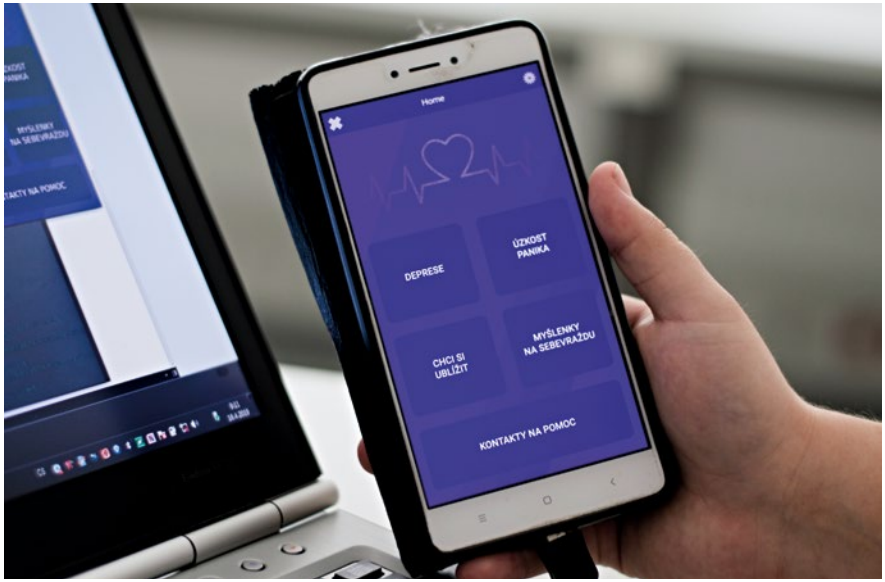



Photo: Oto Jarnoušek

When creating the 'Don't panic!' application Veronika Kamenská cooperated with psychologists and psychiatrists. The application was tested by twenty people with some kind of mental disorder diagnose. The feedback was positive. Apart from methods of small actions and a creation of a saving plan, testers could use contacts to helplines and crises centres. "We were trying to design an application for young people who have difficulties to tell their parents about their problems. The idea


Photo: Oto Janoušek

of describing a problem to an unknown person is much more acceptable for them," Kamenská explained. The application 'Don't panic!' helps in more than 150 countries in the world and during the worldwide coronavirus pandemic it became immensely popular. The mobile application was downloaded by more than a hundred thousand people and it works both on Android and iOS operational systems. "The application is also used by people who do not suffer from any psychological problems. They make use of practical tips how to manage stressful and anxious situations," added the student who wants to extend the application in such a way that it could help to people with eating disorder or OCD.

The Forbes also praised Veronika Kamenská for trying to find innovation ways to help people with mental disorders. She also started a new project Silence is not a Solution, where people can share their own experience with managing their disorders.

On social networking sites they will learn what a visit to a psychologist looks like or about a hospitalisation at the psychiatry. "This is information not easy to be found. People are also worried because they do not know what will happen to them after a hospitalisation," Kamenská described. She is also preparing a portal which will connect verified psychotherapists in training with clients who search for inexpensive help.

"Then I will just finish my bachelor study and finalize the other application which is almost ready and it is now being piloted. It is called MindCheck and it helps therapists to check on their clients' mental states online," says Veronika, who is also a multiple Europe contest winner in yoyo.

Veronika Kamenská is the third student of biomedicine listed in the Forbes 30 under 30. In 2019 Filip Maleňák succeeded with his application Záchranka which enables calling emergency services by an application in a smartphone, and in 2016 Martin Horský was selected for his application Evipa, making easier the evidence of patients in waiting rooms.

## Robotic barman of the future will be able to prepare tens of cocktails

Before the pandemic, everyone probably experienced a long queuing for a drink at a festival or a concert. A team of students from the FEEC and FME has created a robotic barman JustBarit and has proceeded to the finals of the BUT Student Entrepreneurial Spirit Award. An automatic device will prepare one of tens of cocktails for you unmanned.

Photo: Jan Prokopius

"JustBarit is a device that will prepare a cocktail of your choice within a couple of seconds. Up to 6 bottles of different alcohol bottles and 4 bottles of non-alcoholic bottles can be connected to the device. You can easily select drinks you have connected the device with and JustBarit will create a list of drinks you can prepare from such combination. People can thus taste drinks they have never heard of," Alexander Korotynskiy, who is in his fifth year of Cybernetics, Automatization and Measurement at the FEEC, describes the main principle of a robotic barman.

A group of four students from the FEEC and FME hopes they will address a vast number of Czech and foreign customers with JustBarit. "The device can be rented to bars, hotels, festival holders, events and catering organisations, or it could be rented to wedding and birthday celebrations. Or a customer can buy it as a part of a smart household," Korotynskiy lists different possibilities. He started his way into the finals of the contest about a year ago when he wanted to learn how to work with Arduino and ESP. Thus, he created his first version of a robotic barman, but he called it just "Pourer", as it was capable of working with just one bottle. "I understood that it would be just a small project, as there are all teams in the contest, so I decided to develop the original idea better. I asked my friends and we made a small survey if there is anything similar," Alexander remembers the details. As an inspiration they took a big robotic barman from the FEEC which was exhibited at the International Engineering Fair in 2018, where students learn the principles of Industry 4.0. Such device, however, costs millions of Czech crowns, and that is why the group of four students decided to make a barman that would be affordable and which would be suited for renting for a short period of time, e.g. for a weekend, or for a longer period of time, such as months, to some hotel restaurant. "In the Czech Republic or in Europe we haven´t found anything similar. I know that in the USA they are developing something like that, but they are planning to sell it only in the USA," Korotynskiy suggested results of their market survey. BUT students are thus trying to make a robotic barman as cheap as possible, that is why they decided against buying ready-made products and they work with 3D print and milling and they also try to find their

## BUT students presented a first electrical formula

own material in order to cut down the final device price. "Now cocktails can be chosen only at the robot display which we are planning to enlarge. However, in the future an application should be made which would enable selecting a drink in a customer's smartphone," the FEEC student suggested possible developments of the product in the future. His friends from the FME are helping him with a design and a solution. Financial aid from the first round of the contest helped them to cover cost of the development of the functional prototype.

You can see that students enjoy their work from the marketing spot at the www.justbarit.cz. There you can see Alexander proposing a toast to a robotic barman with a drink prepared by itself.

Not only one, but two new monoposts were presented on Saturday 26 June, 2021, by BUT students. Young constructionists from TU Brno Racing are not afraid of challenges, so they not only decided to race with their Dragon X, the tenth model with a combustion engine, but also, they will start racing with their new electrically powered formula. They called it Dragon e1 and they will race with it for the first time in Most. Thanks to better epidemiologic situation the team plans to take part in racing competitions abroad. Last season they ranked 9th in the world list.

Electric formula was a big challenge for the students as they decided to develop all electronic systems by themselves. "Buying ready-made electronics didn't seem a good way to us, as Formula Student is first and foremost an educational project, that is why we wanted to do it by ourselves. In the end, it was more demanding than we expected, but we do not regret it, it as a great experience. To make it clearer, apart from battery cells a battery box contains electronics as well. Each of the six segments has its own panel monitoring temperature and voltage of its cells. The battery thus contains almost 800 cells and it monitors about 96 voltages and almost 150 temperatures. And it is only the battery of the formula," describes the boss of the TU Brno Racing team Dominik Klement from the FEEC and adds that in the world of student formulas this is something quite exceptional.


Photo: TU Brno Racing archive

The members of the team changed quite a lot with shifting to electric drive. Its main part is formed still by the FME, but there are members from various BUT faculties. About a third of the are FEEC students and about a tenth is formed by FIT students.

"Thus, we can create all software in the car, such as control panels, graphic interface for a pilot and for the programme through which we can control the whole car. Monopost data are wirelessly transmitted by our own telemetry tailored to suit the car needs," Klement explains.

# Well-known graduates

## Automatized workplace designed for Toyota and Porsche. A universal robotic cell is launched to the market

Industry automatization will be more and more important for the competitiveness of companies, as it solves lack of qualified workforce, it reduces human factor errors and it makes production faster. Pavel Bortlík and Jan Šimurda, FEEC graduates and founders of Brno ACAM Solution specializing in robotic workplaces development, confirm that. They sell their products to the world-famous car manufacturers. Thanks to a universal robotic cell the company wants to offer the advantages of automatization also to smaller companies. Pavel Bortlík met Jan Šimurda during their studies of cybernetics and automatization at the FEEC. "I was working as a research assistant in a development laboratory and I focused on output control lines where manufactured parts are checked. Honza has been a very good technician and he also worked for CEITEC VUT as a developer. When they met in 2014, both graduates decided to found ACAM company specializing in the development of automatized workplaces, they didn't gain much trust. Two people lacking money, experience and clients network didn't seem likely to succeed in industrial automatization.


Photo: Jan Prokopius

**Pavel Bortlík and Jan Šimurda – FEEC graduates and founders of ACAM Solution in Brno.**

"Companies supplying components for industrial automatization recommended us to specialize in just one branch, e.g. food processing industry or expedition. However, we liked variety," described Pavel Bortlík the beginnings of the company which nowadays has more than a hundred successful projects and it supplies robotic workplaces to companies like Toyota, Rolls-Royce, Porsche or Honeywell.
ACAM Solution has developed, for example, automatized soldering stations, polishing and glue robots or devices for gearbox completion. Nevertheless, they do not focus only on car manufacturing. Robotic workplaces, single-use machines or tailored software are sold to pharmaceutical companies or toys manufacturers.

"We are pure technicians and developers. When someone shows us a manufacturing process, we try to understand it from the very beginning. We do not communicate just with management. We tend to go to workplaces and we ask workers if the requested products will really help them or if there are any other problems which we can include in the new product. We are trying to make use of currently

accessible technological solutions and we put them into a functional unit. We cooperate with excellent European suppliers and if some technology is not available, we develop it ourselves," explained Šimurda what the added value of their work is.

Currently, technicians in ACAM are developing a universal robotic cell which gives advantage not only to big industrial manufacturers, but also to smaller enterprises. Within 10 minutes it is possible to set the device to a different kind of activity. "Nowadays, the times are changing rapidly. What is being manufactured today, needn´t be manufactured tomorrow, be it due to design changes, European standards or due to the beginning of electric cars. Many companies thus fear big investments into a single-use device or they are not able to use it to its full capacity. That is why we wanted to offer them an automatized device which would be universally usable and a customer will be able to change flexibly the manufacturing programmes," says Šimurda. The company decided to patent the universal robotic cell and currently is working on its improvement.

After 7 years the company from Brno has a turnover nearing 100 mil. CZK and it grew from two founders to 30 members of the team. In Želešice by Brno, on a field of 6,000 $m^2$, they are planning to build a development and research centre which will be intended for about a hundred technicians. "We will have to search for new employees and they needn't have many years of experience. I usually ask the applicants at the job interviews if they ever disassembled their own car or if they ever tried to weld something in their garage with their dad. What is more important for us is their enthusiasm and willingness to learn," says Bortlík.

Photo: ACAM archive

## People are curious if the cars can outsmart them, but we must keep in mind that they are only things

He designed distribution boards, he programmed and went abroad on business. Finally, Jan Průcha, a FEEC graduate, ended up in Valeo, an automotive company which develops assistants capable of controlling a car almost without a driver's intervention.

"I wanted to study automatization, but at the entrance exam I didn't reach the point average necessary to pass. After the enrolment there was a free place but I had already got to the Telecommunication and Information Technology, so I remained there. I was happy because I had free Fridays. And where else can you get so lucky?" Jan Průcha laughs when remembering his beginnings of his studies. During his studies he already tried out fields more or less close to telecommunication. His first job took him to industrial automatization. When his friend from FME offered him to work in Valeo, he accepted.

"I became a part of a team that makes assistants to cars such as keeping a car in one lane, adaptive cruise control, parking assistant, or braking ahead of obstacles. We are working both on sensors as well as on software which controls the car. There are departments focusing on development of rear and sidemirrors, ultrasounds and radars. Every other car has

Photo: Valeo archive

**Cars can change speed by themselves, keep a lane or brake when an obstacle appears.**

ultrasound sensors by Valeo," Průcha explains. Cars have been making use of ultrasound for a long time to warn the driver against an obstacle while parking. Nowadays, they can even park by themselves. In Valeo the aim is clear: a customer, i.e. a car manufacturer, makes a request and the developers' task is to come up with a solution how to reach the goal. "We put own cameras and sensors on the car and we create a so-called map of objects which is based on the data from more sensors. The car is then ready to interact with them in real time. For instance, while parking the car needs to find a free place. The car then has to be able to count angles and find out the smallest number of gear stick movements it will need to park," he gives one of many examples and he adds that currently he is working on braking while reversing, which can be really useful e.g. when going out of parking place in front of a supermarket. "If the car detects a pedestrian by a sensor, it sends a visual or a haptic warning to the driver. At this point the brake is not activated yet. We wait with braking until another signal is added, usually an ultrasound, and only then the car starts braking," Jan Průcha explains the principle of automatic braking when detecting a pedestrian. If all technologies by Valoe were installed into one car, it would be autonomous at the fourth level.

That would mean that a car is always autonomous except for substandard situations. In order to accept autonomous cars, it is though necessary to improve the infrastructure and to make a new legislation. Nevertheless, these technologies make easier tiring and potentially dangerous situations on the highways. Among so-called active safety technology you can find emergency braking or steering wheel vibrating when hitting a roadside. An adaptive cruise control and keeping the lane are functions that keep drivers feel comfortable.

Průcha explains: "If you set a cruise control to 130 km per hour, a car can surpass you and then it slows down to 110 kmph, you can easily reach it, but your car will slow down automatically in order to keep safe distance. If a car I front of you speeds up, the cruise control will set be back to 130 kmph. An autonomous car can also react to situations when a car in front of you starts direction indicator or its brake lights have gone on. The car can be taught this as well."

## Start-up GroundCom plans a network of ground stations for communication with small satellites

A discreet company GroundCom is not short-sighted, as it looks into the universe with its plans. Peter Budáč, a FEEC graduate, has always been interested in space research and after his experience from Switzerland he now uses his knowledge in a start up in Brno, which was supported last year by the European Space Agency.

GroundCom company builds a network of ground communication stations whose task is to keep contact with small satellites like cubesats or microsats. Their popularity grows immensely. Their solution would help to prolong contact between ground and the satellites from a couple of minutes to several hours daily.

"Small satellites are definitely trendy. They are small and light, thus much cheaper for transportation to space. Thanks to that even smaller companies or universities can verify their technology right in the space, like radiation, pressure and temperature measurement, telemetry, imaging universe, checking photovoltaic cells and many other. The variability of cubesats is incredible," Peter Budáč, a microelectronics graduate, described advantages of small satellites.

Photo: Jan Prokopius

Together with his classmate, Michal Mrkna, who studied communication technology, they work in GroundCom.

"There are clients who have one own antenna, but it enables a connection with a satellite just for fifty or sixty minutes a day. A satellite has to travel round the Earth very fast in order to avoid gravitation, for example it orbits the Earth twelve or sixteen times a day. Thus, from one place at the planet such satellite is trackable only for a short time. If we could build a whole world network of ground stations, we could communicate with the satellite for about six hours a day, which means much more data and their better analysis," Budáč explained. Nowadays, about a thousand small cubesats are orbiting the planet, but their number is growing steadily. "This year we would like to finalize an antenna that would be placed right her in the South Moravian region. Our next year's aim is to build stations in India and Canada, which would enable covering three continents. An ideal aim is to have about seven stations around the world," Budáč suggested. His task in the GroundCom is to care about quality of products and checking the antennae development. During his studies he first worked in the Institute of Scientific Instruments of the Czech Academy of Sciences (UPT AV) and later he moved to Swiss company RUAG where he focuses on aerospace engineering.

He believes that his start-up has a great potential, as it belongs to the ESA space incubators.

"Space research has certainly a great future. It is obvious that resources will be finished one day and we will have to solve it. We can see it on current research, be it potential raw materials mining on asteroids or a new space station on the Moon orbit, and many other. This market is growing exponentially," Budáč commented on the current situation. He has been interested in space ever since early childhood when he was browsing through Slovak Kozmos magazine.

Even though the ESA incubator secured mentoring and space for JIC to the team, the company has adapted to the new situation and it researches online. "One team member is in Great Britain, another one in Germany and other two members are in Bratislava. We thus meet once in a while, but most things are solved online. We also have customers from the Czech Republic, Italy and Great Britain. An American market is a great challenge where similar services are available, but they are much more expensive," a FEEC BUT graduate suggested near future.

Their work goal is to secure communication with mission to the Moon. "As the cubesats are orbiting the Earth, they will also orbit the Moon. We can also see a great potential in here," Peter Budáč smiles.

## A philharmonic concert master and ice hockey player play the printed violoncello

Did you know that when a violoncellist travels with his musical instrument, he has to buy an air ticket to it? It is quite expensive and not even extra money can protect the instrument worth thousands of Czech crowns against damage. A novelty appeared at the Czech market last year which can fit in the violin case. Some classical music fans might find it too bold and unsuccessful, but a violoncello from the 3D print by a BUT graduate won more than a million CZK in a fund-raising campaign and it was introduced at the Brno Philharmonic Orchestra.

"Vanessa-Mae does not care about Stradivari's violin creation methods about 400 years ago. She tries to innovate and to make young generation interested in her play," says Jan Tobolík into the computer camera in his Přerov company, where he returned back after his studies at the FEEC BUT. On the desk next to the monitor there is the main object of the conversation, i.e. a violoncello printed in a hundred hours by a 3D printer. It does not have its traditional round shapes with cut holes of warm polished wood and only strings on a red plastic fingerboard suggest that it is a musical instrument. The original idea came during the coronavirus crisis which increased the popularity of 3D print. Instead of mask shields Jan Tobolík with his

Photo: MyCello archive

colleague Ondřej Kratochvíl started printing musical instruments. Originally, the idea came to Kratochvíl, as he not only plays the violoncello himself, but he also teaches it.

"During the pandemic my colleague had to stay at home and he couldn't practise. Or better, he could have, but his neighbours wouldn't be very happy. He wanted to buy a quiet cello, but he couldn´t find a suitable one," Tobolík remembers last spring. They both realized that such loud voice of the string instrument has to be shifted from residential halls into headphones in order to keep his neighbours (and musicians) satisfied. The cello was designed to have only the most important for play, i.e. chest rest,

armrest and knee rest, and also a sting. They installed electronics and sensors as well as connectors for headphones plug-in into the body of the instrument. They created an instrument that can compete with the cheapest alternatives at the market, but, in their opinion, it has many more advantages.

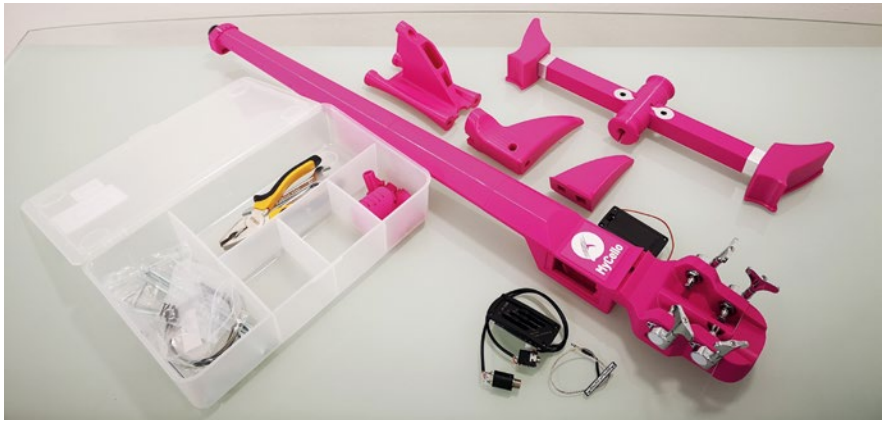


Photo: MyCello archive

"When a colleague wanted to leave for a concert with his band with four violoncellos, he had to take a van. Thus, he wanted an instrument that can be folded like a Swiss pocket knife," Jan Tobolík explains another advantage, and adds that their cello can fit in the violin case. This can help not only when travelling, but it will also help kids' backs when transporting the cello from home to lessons. MyCello, as the project is called, is made in 6 sizes and it is suitable for kids from the age of five.

The biggest advantage of MyCello, though, is not its compactness or a possibility to have it printed from a shining material, but the ability to make an instrument tailored to suit the musician's needs. As violoncellos do not have frets like guitars, players must have a perfect touch memory to play the strings correctly. If a place where the player rests their thumb changes even slightly, they have to adapt to it for a long time before they master it again. "If we measure about six parameters, we can make a relatively cheap version of a wooden instrument.

A musician can take their MyCello for holiday easily or play at home and they do not disturb anyone," Jan Tobolík explains. He also adds that their task is not to replace traditional violoncellos, but to help in situations when a wooden instrument is an obstacle. "We have a customer who own a yacht and he wants to practise on holiday by the sea as well. His only cello always got damaged, and this will never happen to MyCello," Tobolík smiles happily. Isn't a cello by an entrepreneur from Přerov just an eccentric apartment accessory? "It was an honour for me when even during a crowdfunding campaign Brno Philharmonic master Pavel Šabacký decided to buy MyCello. This year, after 38 years he finished playing and at a good-bye party his quartet played almost half of the music on our cellos. He played for 38 years the classical violoncello and at the end of his career he showed that he was not afraid of modern technologies," the BUT graduate comments proudly. A printed cello is not only for professionals. "We have customers who said that they were thinking of starting to play the cello, but only our MyCello made them try it. Among them there is also an ice-hockey player from Přerov." Another step in the development is to print metal components, to launch a new edition of instruments with better sensors and to discover how to set 3D print so that the plastics didn't muffle the sound, but, on the contrary, it would spread it better. "We have a functional prototype of a contrabass and people also asked us if we are able to make a viola," Jan Tobolík says. He also suggests that if the interest grows, more musical instruments can be made.

# Well-known employees

## Extended reality is not only a Pokemon hunt, but it can also save people from a fire

Special goggles imbedded in a fireman's helmet that would lead him to a water source or to people blocked by smoke and closed doors would help a firefighter to orient in a burning building. Similar to an action game, a firefighter would see orienting points, emergency escapes or distribution boards, even through walls. "Our aim is an advanced detection and navigation through a building telling a firefighter that he is now passing by a door where people are hidden. Together with this he will also see where his colleagues are," Kryštof Zeman explains one of the main goals of the project. He carefully pulls out goggles from a case, which a manufacturer describes as a device for a hybrid reality. Today, HoloLens are mainly used by designers and architects who, sitting comfortably in their offices, can model in the air by their hand anything that comes to their minds. Researchers from the Department of Telecommunications and developers from GINA Software company came up with an idea that this technology could be adapted for emergency services needs. Together with the Czech Association of Fire Officers they got dotation from TA CR.

Photo: Jan Prokopius

"In a fire a firefighter may not see well and they do not know if there are people in the building, so they can be helped by the goggles. The goggles can add information in real time, for example while a firefighter is walking through a corridor, he can see navigation through a building or he looks at a wall and he gets information that this way in ten meters there is a main gas valve, a distribution board, a fire extinguisher or a water pipe," Zeman describes the main useful functions. He adds that in Malaysia buildings are equipped with a digital model containing all the important information and it would be easy to load it into a similar device in case of fire. A firefighter who has never been to the building would easily orient there, even if it was a twenty-storey hotel where all the floors look alike. And how could the system detect

Photo: Jan Prokopius

people hiding against fire?
"We need to rely on Bluetooth or Wi-fi, i.e. technologies mobiles, tablets and other portable electronics use.
Thanks to the signal coming from them we can say how far a firefighter is from such a device. We can compare it to a computer play where I would play with more people, but they wouldn't see me and I would see their positions," Kryštof Zeman explains. It is also important to know where in the burning building his colleagues are, which can be complicated by a thick smoke.

GINA Software has been providing coordination technology for emergency services for a couple of years and goggles for extended reality are another step. Researchers need to face the following problems, as Kryštof Zeman enumerates. "For start only a commander will have the goggles and he will navigate his fellow firemen by a radio. At first, we were thinking of a commander staying in a helicopter where he would monitor the situation and saw the positions of other firemen and other points of need. However, we found out that goggles do not work well outside. They are reflected information by a system of mirrors and waveguides and if it's sunny outside, you do not see anything. Goggles also do not have a GPS and they orient by sensors, so if you fly above the object, they do not have any coordinates to follow.
That is why we will use a tablet or a phone with a GPS and camera which can guide firefighters even from the air. In the meantime, we will secure GPS to the goggles from a different device, e.g. an external GPS antenna.
We will analyse the possibilities of smart goggles which, unlike those from Microsoft, will work on Android. That would mean that they would use the same things as phones." It would seem that a modern smartphone would manage the work as well and, moreover, it could connect to GPS, but this has its limitations. "We are trying to move from Pokemon hunt to technology that can save human lives. A firefighter will never run with a telephone in hand around a building, that is why he will need to have smart goggles embedded in a helmet. Another step is to find out how the new technology could be embedded into the helmet without adding more weight to firemen's equipment.
"Goggles are still quite big.
It might be good to disassemble them into components and they can be embedded step by step into a helmet. They must not block sight and withstand high temperatures.
The challenges are many," the young developer comments and he remarks that BUT electrical engineers' task is not to manufacture modern firemen equipment. "We want to show that we have done something everybody said is impossible." This would be other people's task to speed up manufacture and apply it to real life. "A researcher's task is not to do the things other people do, but to come up with something new, even though quite a lot of work needs to be done further on."

## Switched-off Brno showed sources of light pollution

During the night from 10 to 11 April 2021 street lights were switched off for many hours in Brno. The aim was to find out how much Brno is polluted by light. Apart from aerial imaging, Petr Baxant from BUT was also observing in person.

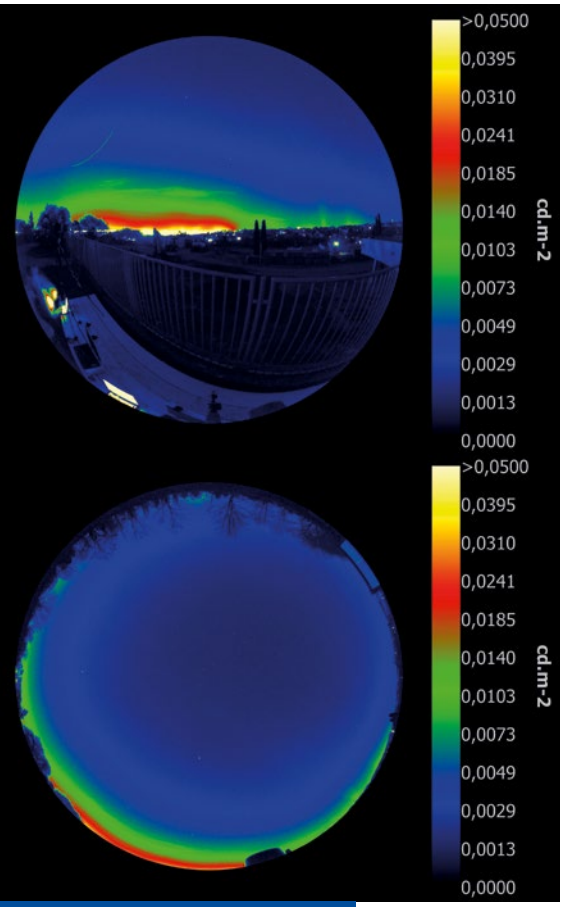



Photo: Petr Baxant archive

First results are showing that street light on the one hand creates light pollution, but on the other hand, the effect would be much bigger if private objects and grounds were switched off as well. "By switching off street lights the brightness was reduced by 45 %. It's not much, but we must take into consideration that street lights are regulated and at night hours there wasn't a hundred percent maximum. The test has showed that objects outside Brno administration influence the level of night light much more. We will be interested in finding out which objects are dominant and how many there are. These would be the ones we would focus on in the next measuring," Petr Baxant summarizes some of the data.

The resulting images are coloured into so-called pseudo colours reflecting brightness colour scale. Human eye is sensitive to brightness and it perceives contrasts a lot. A monitor or a display brightness ranges from hundreds of candelas per square metre (candela is a unit of luminous intensity), while e.g. full Moon surface has brightness of 3,500 cd/m$^2$, which is about a thousand times more than Castle Spielberg brightness lit by architecture lights. Artificial lights of such façade are about twenty times bigger than a natural Moon shine. "Round images from fisheye lens show us zenith, i.e. the whole upper hemisphere. Here we have interesting numbers from brightness calculation caused by poorly lit sky. At the point of measurement there was only 0.008 lx when street lights were switched off. This is about thirty times smaller number than we could get in a very bright full Moon," Baxant explains and adds that even very bright Moon light can influence the measuring. His team constructed a brightness analyser which enables Moon brightness to be deducted and to be replaced by background. An ordinary luxmeter does not allow such measurement. Nevertheless, in the time of measuring the Moon wasn't visible.

"Our test was really unique. We were ready and managed it. We will start a new stage of research thanks to that. The public could think that the numbers are small and we needn't be interested in such a topic. It will probably not be possible to find the real zero brightness background, i.e. the one that only stars reflect together with a natural light from the planet atmosphere. Nevertheless, we would like to make it as close as possible and to find out how we stand in comparison to other places in the Czech Republic and other places on the planet," ends Petr Baxant positively.

Photo: Jan Prokopius

**Pavel Neužil works both at the FEEC and CEITEC BUT and most of the year he spends in China.**

## He is able to find out the gender of a suspect within couple of minutes and right on the spot

Most of us know the work of criminal investigators only from TV. TV heroes carefully collect scent traces into plastic bags on the crime scene in order to comment on them long in the laboratory on the camera. However, in real life time is crucial and every minute of delay can mean a smaller chance to catch the culprit. The device Pavel Neužil is working on could be used right on the crime scene and it could detect whether it is man's or a woman's DNA. And such information could be crucial for the investigation. Scent traces can serve pretty well in such case. "On the crime scene samples are taken, they are put in a solution and our device can analyse it. In Star Trek they had a so-called tricorder, which was a box somebody put on your skin and immediately learnt what illnesses you have. Our device cannot do that, but it can tell you if in the sample there is the thing you are searching for or not, such as a gene or a virus. However, you must know what you are looking for," Pavel Neužil, who works at the FEEC and CEITEC BUT, explains his cooperation with Criminologist Institute.

Together with scientists from other universities he develops a system following the principle of point of care, i.e. analysis on the spot where the sample was taken. The device is the size of a mobile phone and it contains heating, cooling, LED diodes and electronics for the whole operational system. This small system

is able to detect the information in search. It can be a genetic information of a suspect, or a presence of a coronavirus at a patient.
In the detection of COVID-19 Pavel Neužil cooperates with Military Medical Institute and the Mendel University.

"The sample is immersed in a solution where the casing of cells is broken. If it is a coronavirus, it ceases to be dangerous. In scent trace we want to know whether it is male or female or animal. In such case we are looking for chromosomes X and Y. In Covid we are looking for a specific RNA sequence. In the solution you add magnetic particles, the solution is shaken and we pour it with oil.

Finally, we take a small amount with magnetic particles by a pipette. The magnet in the device draws the particles in the solution, which removes the remaining solution. RNA from the particles is released and transcribed. RNA is transcribed into DNA and then the well-known PCR test, which is a chain reaction, follows.

This helps us to find the sequence proving the virus presence. Even if we had just one DNA or RNA molecule, we are able to find it," Pavel Neužil describes the principle of the device functioning.

The whole procedure is evaluated by a generated fluorescence and on a display or a mobile phone the user can see the information he was looking for. The aim is to create a system easy to use. "Ideally, a person taking a sample could put the sample in the test tube, shake it, take 50 ml put it in the container in the device and push a button."

Scientist are working with solutions from the specialized laboratories. The advantage of the new device is its speed, Pavel Neužil stresses. "The result should be ready within 20 to 30 minutes. The sample needn't be taken anywhere. It is not even necessary to wait until a large number of samples is gathered. This is the reason why it takes about one or two days to get the results for the PCR test.

The device could help to detect the presence of other illnesses like HIV virus or maybe cancer. According to Pavel Neužil it is probably best for detecting illnesses that spread fast and easily, such as respiratory diseases.

Photo: Jan Prokopius

**In the FEEC BUT laboratory they do not work with coronavirus for security reasons.**

## BUT electrical engineers tested the effects of speleotherapy as well as natural phenomena in Amatérská cave

The karst near Brno is rich in caves with preserved domes and corridors. An underground visit is not only an interesting tourist attraction, but it can be a healing method for asthmatic kids which can improve their lives. In order to preserve both effectiveness of the healing and natural beauty, the researchers from the BUT have been doing their measurements right in the caves. Nowadays they cooperate with natural scientists from the Masaryk University and they are testing how agriculture or tourism in the nearby Amatérská cave is reflected e.g. in the quality of the underground Punkva river.

"Before discovering accessible medicine with corticoids, a climatic stay in the cave was practised as a method of healing. In Sloupsko-šošůvské caves in Ostrov u Macochy a sanatorium for children was built. Half of the time the kids were supposed to exercise and the other half they should relax. It proved that after a longer, say three-week stay in the caves, children suffered smaller problems with asthmatic attacks when adult. I got into the research thanks to Zdeněk Buřival, who measured aerial ions in the caves," Zdeněk Roubal from the FEEC remembers the beginnings of the research. Speleotherapy, i.e. a healing stay in a cave climate, also works thanks to the presence of limestone containing thorium and uranium. Disintegration products lead to radon which by flitting in the air ionises neighbouring neutral particles into negative, which are scientifically proven to have beneficial impact on human health. Moreover, karst caves contain magnesium and manganese aerosols which help asthmatic patients with expectorating. In order to have a perfect healing effect, the cave has to be clean, Roubal warns: "If children went to the cave without a special regime, they would bring remnants of food and fibres from clothes. In some caves, patients have to take off clothes before the stay, in other countries they sometimes cut off the upper layer of the cave, which is very expensive. In order to avoid this, it is necessary to set a good regime in the cave. Our research started at the point when we wanted to learn if the cave's climate is not exhausted by kids' stays and thus the healing potential is not reduced."

The researches met many problems. A long stay in circa seven degrees of Celsius is not ideal for research. Almost a hundred percent humidity, though, proved to be a bigger problem which would put measuring devices out of order within half an hour. Roubal with his colleagues thus started to work on improving the devices that would send them the data on the fly. They managed to cut down the amount of time needed for synchronising the data from all day to one hour. The improved devices now

Photo: Zdeněk Roubal archive

help the BUT and the Masaryk University researchers in the inaccessible Amatérská cave. "We are researching the influence of the outer environment on the cave. Punkva goes through Amatérská cave, which is the same water as in wells supplying surrounding villages, that is why it is necessary to know if the water quality does not change," Zdeněk Roubal explains. Unlike the cave intended for speleotherapy, in Amatérská cave there are no concrete pavements, nor even electricity. All devices thus have to be battery supplied and in order to exchange them researchers regularly have to go down the longest cave system in Europe. Despite occasional difficulties Zdeněk Roubal enjoys going underground. "In October, for example, a flood came and it was a great luck we didn't have the most expensive devices installed, or we would have lost them. We are still interested in what influence humans and their activities have on caves themselves. There are still some phenomena which we do not understand why they occur. We would like to find it out and help to preserve caves as beautiful as they are."

## Biomedical engineers from the FEEC now print part of tissues. Bioprinting helps not only in research

An artificial vessel, a healing plaster or implants with prolonged drug release healing where needed. These are examples of research tasks which biomedical engineers from the FEEC BUT face. Now they can experiment with the so-called bioprinting. While 3D print is an inherent part of many fields, prospective medical technicians are discovering the possibilities of 3D print from medical materials. "One of the most interesting things is an artificial vessel which can simulate physiological functions and mechanical properties of a real vessel. Thanks to a new bioprinter we can make basic vessel constructions in flow chambers whose walls we plant with cells and we observe their behaviour under different situations and conditions. This can be connected with a system that can simulate blood flow, which simulates an artificial vessel even better. Thus, we can do further research," Vratislav Čmiel, laboratory director from the Department of Biomedical Engineering, describes one of the possible 3D print products.

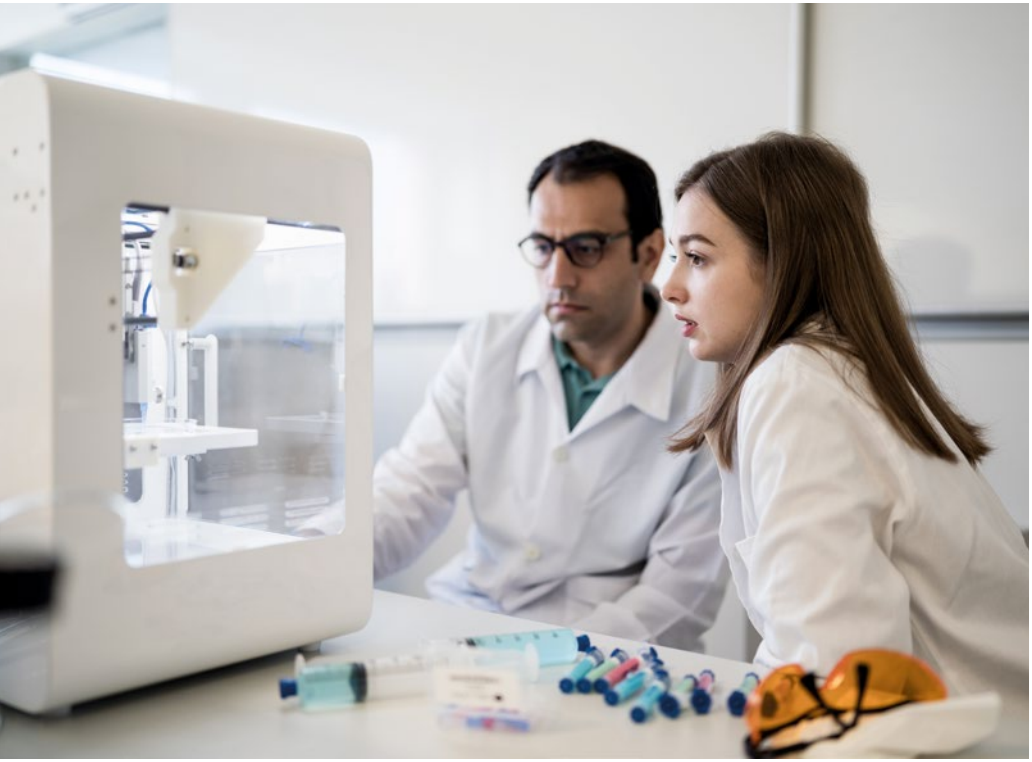


Photo: Jan Prokopius

**Biomedical engineers can now use a bioprinter at the FEEC and they can even print parts of tissues.**

Right there, in the Laboratory of Biophysics and Laboratory of Cell Engineering, they focus on creating vessel constructions in laboratory scale, which helps not only to primary research.

A special printer works with a bioink that can improve regeneration of a certain area by its ingredients, as it contains skin, bone tissue or cartilage healing substances. This biocompatible material is pressed by two heated nozzles onto a prepared dish. Under the dish there is a heated table that preserves the properties of the printed material.

The leader of a five-member team says that they do not print artificial organs, but only some parts of them or parts of tissues. "We are focusing on regeneration medicine where we gradually start cooperation with clinical

practise. We are now trying to grow a certain substitute of tissue made by biologically compatible material. It is a sort of a patch for better wounds healing, not only of skin, but also for implants. When we make, for example, a plastic implant inserted in a patient's body, a biomedical engineer can print a healing layer that helps the body accept the implant. The layer can be made by printing the supportive material or it can be planted with nanostructures carrying e.g. antibiotics or drugs and they thus help to heal a concrete area," Čmiel suggests the possible use in medical practice.

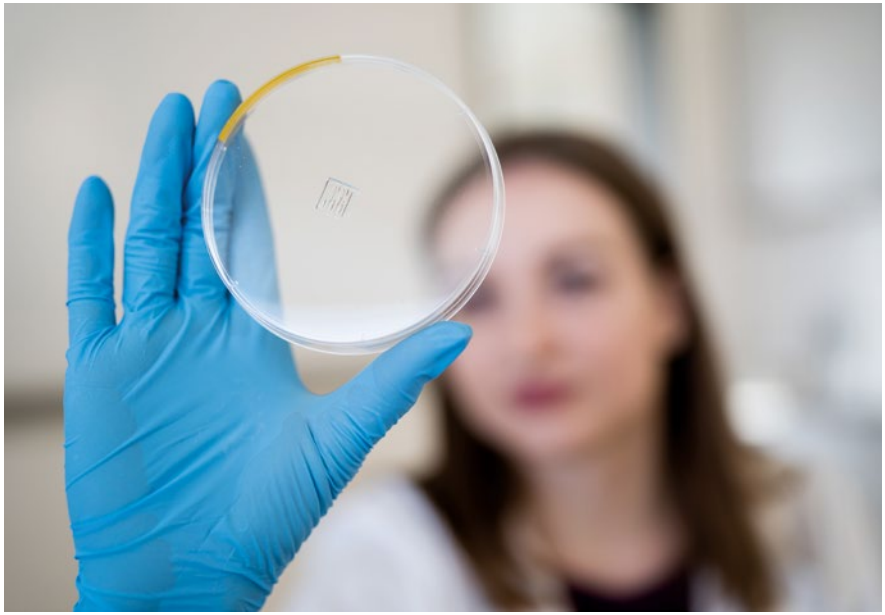


Photo: Jan Prokopius

**Various shapes and structures help researchers in cell and tissue engineering**

The new bioprinter enables the FEEC researchers to print parts of tissue of different shapes and structures and it helps them in research of cell and tissue engineering, primarily in cardiology and regeneration medicine.

"Thanks to bioprint we can print various supportive structures, e.g. meshes, or certain constructions or surface for cell cultivation. We create different barriers and we observe how they pass through them. Our aim is a directed cell migration which would target a damaged area and help to speed up healing wounds," Inna Zumberg, the researcher, adds. A successful operation is not just the result of surgeon's smart hands nowadays. More and more, it is the result of cooperation of doctors and biomedical engineers.

They are usually not in the operating theatre, but they prepare the background for doctors and thus they help to a successful intervention.

Modern bioprint procedures as well as normal 3D print in medical practice will be introduced not only to students of Technology in cell engineering, but also to doctoral students during their research. Biomedical laboratories offer cooperation not only to medical workplaces, but also to clinical practice in general.

Photo: Jan Prokopius

A surgeon has two models of spine for each patient, one for training and the other for orientation.

## 3D print of children's spine models helps doctors in treating scoliosis

An interdisciplinary project between the BUT and the University Hospital Bohunice deals with space analysis of power stress, using correction force modelling. It aims at minimising scoliosis in pre-school children and it reduces greatly the number of surgical interventions. Two FEEC departments together with the Faculty of Civil Engineering work together on the project.

"Scoliosis is the most frequent spine deformation in young age. It is only the early treatment that can influence greatly what problems there will be in adulthood. Conservatory treatment, unfortunately, is not always enough, with a certain incurvation degree an operation is inevitable," Milan Filipovič from the UH Bohunice orthopaedic clinics explains. In case of progressive deformity, it is thus necessary to intervene as soon as possible as long as the deformed part of spine is as small as possible.

This increases the probability that a spine will evolve under normal conditions. Filipovič had an idea of creating a 3D spine model that would help the surgeon learn how to lead the operation on the smallest part of spine possible, so that it would not have influence on its further growth. He decided to ask his colleagues from the BUT to create that.

"We cooperate with the UH Bohunice in the long run in many interesting projects. Four years ago, we succeeded with this project at the Czech Health Research Council. Our aim was to analyse data from CT scan and magnetic resonance using AI. Researchers from the Department of Theoretical and Experimental Engineering and the Department of Telecommunication first optimized methods of imaging segmentation in order to create 3D spine models. Colleagues from the FCE then helped them with modelling of mechanical forces distribution," Jan Mikulka, the leader of the project, concluded.

A finalized spine model with a quality surface and with precise space resolution is then printed at the FEEC at a special full-colour powder 3D printer. A surgeon always has two spine models at his disposal, one for training before the operation, and the

other helps him with orientation during the operation. So far, twelve such operations have been performed and, after a short break, other will follow.

"However, first we want to close the current group of patients, so that we could compare achieved results with a time interval. In the future we would like to replace a CT scan by MRI to avoid x-ray," Filipovič added.

Not only him, but also his BUT colleagues believe that project results have the potential and conditions to be used for commercial purposes. In the future he is open for discussion with health insurance companies for starting to cover the treatment.

Photo: Jan Prokopius

**Cooperation between BUT and the University Hospital Brno bears results.**

# Important awards and merits

## Brno Ph.D. Talent Award

Richard Ředina, a doctoral student from the Department of Biomedical Engineering, excelled in Brno Ph.D. Talent contest. He ranked among 25 best doctoral students of four Brno universities. Richard Ředina succeeded with his project of using deep learning methods for heart arrhythmia defects. The aim of the project is to develop algorithms which can detect chamber fibrillations in routine cardiology clinical practice. Ředina practises his research in cooperation with the St. Anne's University Hospital Brno. Brno Ph.D. talent contest is intended for excellent first year doctoral students of Brno universities. A scholarship of 300,000 CZK for the award enables the student to fully focus on doctoral study and scientific research.

Photo: Jan Prokop Plus

**A young researcher from the FEEC was awarded with Brno Ph.D. Talent.**

## Werner von Siemens Prize 2021

A microelectronics graduate, Ing. Lukáš Kuřímský, got to the Top 10 best diploma theses in Werner von Siemens Prize. Ing. Kuřímský introduced his diploma thesis on "Device for automated testing of gas boiler controllers" which he realized for the Honeywell company.

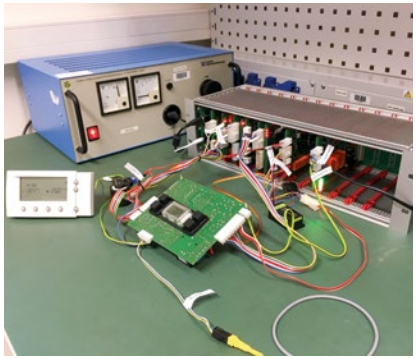


Photo: UMEL archive

Photo: Jakub Rozboud

**FEEC Ph.D. talent 2021 awards.**

## FEEC Ph.D. talent 2021 Contest

Supported by BUT Institutional Development Project, the FEEC faculty was looking for talented Ph.D. students, who had undergone two-round evaluation. In the second round, students presented their current and future results in front of the evaluating commission. 8 excellent students were selected to be awarded with an exceptional scholarship of 210,000 CZK altogether.

Major prizes of 75,000 CZK were awarded to Jana Schwarzerová (UBMI) and Karel Juřík (UTEE) by the FEEC dean. Other six finalists were awarded with an exceptional scholarship of 10,000 CZK and these are Iveta Lolová (UVEE), Ali Hamza (UBMI), Jan Klusáček (UEEN), Filip Mívalt (UBMI), Jakub Nemček (UBMI) and Radek Závorka (UREL).

Photo: Jan Prokopius

## BUT Rector's Golden Medal

The Rector awarded prof. Ing. Eva Gescheidtová, CSc. from the Department of Theoretical and Experimental Engineering for her lifelong results and merits for development and quality of university activities at the BUT. An intimate informal meeting, postponed due to coronavirus to 20 January 2022, was replaced by a ceremonial academic gathering at the rector's auditorium at Antonínská, which had been previously cancelled due to epidemiologic situation last year.

## BUT Rector's Silver Medal

The Rector further awarded prof. Ing. Petr Toman, Ph.D., a current head of Department of Electrical Power Engineering, for his extraordinary merits in the BUT development of electrical power engineering.

## PhysioNet/CinC Challenge

A team of researchers from the Czech Academy of Sciences, including biomedical students, graduates and teachers, won triple times a cardiological contest PhysioNet/CinC Challenge 2021. The scientists were awarded for developing algorithms for automatic detection of heart activity malfunctions from the ECG signal. The scientific team was awarded at the 48$^{th}$ Computing in Cardiology international conference organized by the Department of Biomedical Engineering, FEEC BUT.

## Josef Hlávka Prize 2021

A Power Electrical Engineering master program student Robin Kolařík was given Josef Hlávka Prize for his diploma thesis in which he focused on energy flows in a town under 3,000 inhabitants with a high percentage of photovoltaic panels. Based on his research he evaluated daily power flow and voltage ratios in the electricity network.

Photo: UBMI archive

**Professor Jiří Jan launching his book Medical Image Processing, Reconstruction and Analysis: Concepts and Methods, Second Edition.**


Photo: ÚPT AV ČR archive

**The team awarded in PhysioNet/CinC Challenge researched heart failures by the artificial intelligence.**

## A book about processing biomedical images succeeded in an international book list

A book by professor Jiří Jan about processing medical images: Medical Image Processing, Reconstruction and Analysis: Concepts and Methods, Second Edition, was listed by Bookauthority among a hundred world most influential books in image processing.

The publication ranked 80th in 100 Best Image Processing Books of All Time. The same book then ranked 52th in 100 Best Signal Processing Books of All Time. The book presents basic principles and methods of image processing related to application in biomedical imaging.

# RESEARCH AND DEVELOPMENT AT THE FEEC

Photo: Oto Jaroušek

## Projects

The Faculty of Electrical Engineering and Communication is a unique place dedicated to research and development focusing on electrical engineering and other fields, such as biomedical engineering or material engineering. Our research teams work on solving research and development problems not only individually, but also in cooperation with other universities or with our partners from industry when participating in national or international projects and consortia funded by European Union programmes.

# Fields of Research

At the faculty there are many scientific teams focusing on research and development activities in projects solved with faculty partners from industry.

They also focus on contractual research commissions where they achieve important and valuable results.

## Research Teams:

- AUTOMATION, ROBOTICS AND SENSORICS
- MICRO- AND NANOELECTRONICS
- BIOMEDICINE AND SIGNAL PROCESSING
- RADIOELECTONICS AND COMMUNICATION TECHNOLOGY
- ELECTRICAL AND ELECTRONIC TECHNOLOGY
- TELECOMMUNICATIONS AND INFORMATION ENGINEERING
- INFORMATION AND CYBER SECURITY
- POWER ELECTRONICS AND ELECTRICITY

Photo: Jakub Rozboud

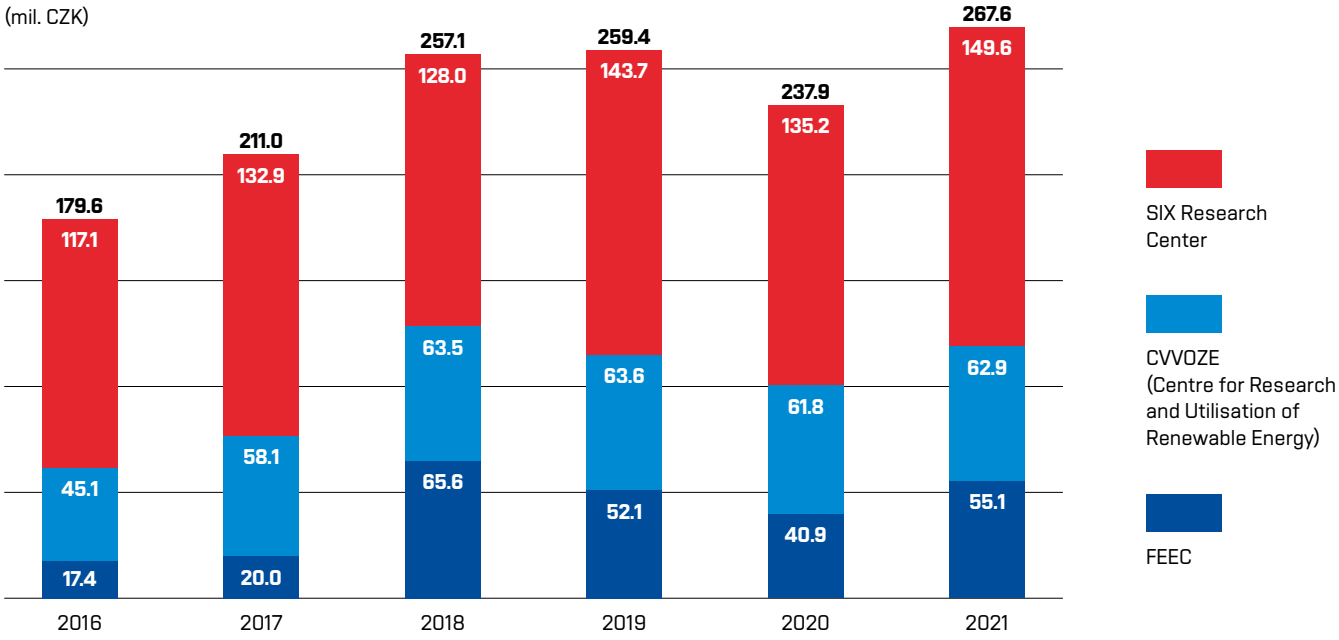
# Research and development in 2021

In 2021 FEEC researchers solved over 180 projects in cooperation with industrial and foreign partners and the overall value of the financial support exceeded 243 mil CZK.

Main providers of financial dotation for project of basic and applied research are Technology Agency of the Czech Republic (TA ČR), Ministry of the Interior of the Czech Republic (MV ČR), the Czech Science Foundation (GA ČR) and Ministry of Education, Youth and Sports (MŠMT). The biggest grant projects at the FEEC go on researching e.g. high-revolution systems for thermonuclear fusions, systems for cybernetic security of communication networks by using post-quantum cryptography, complex evaluation of optical fibres network security risks, specific sources of indefiniteness and dysfunctions and their elimination during the process of integrated radiofrequency subsystem designs, new electrochemical energy depositories, i.e. Natrium-ion accumulators, or the so-called intelligent energy networks characterized by improved reliability and a shorter period of regeneration after a failure.

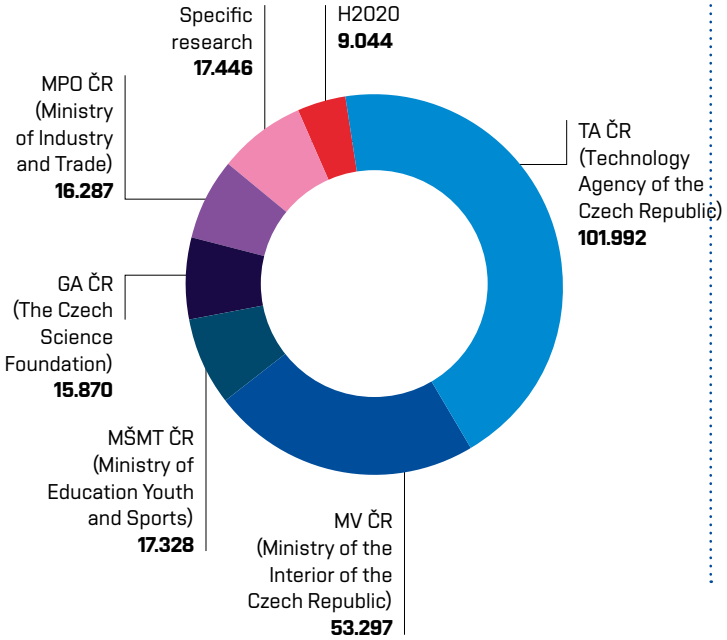
**The distribution of financial support of research and development between research centers and faculty departments**

(mil. CZK)



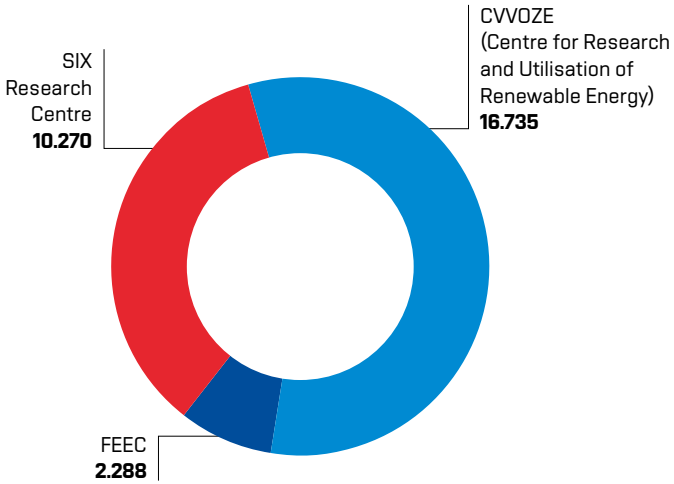
## Main providers of R&D financial support in 2021

(mil. CZK, sum total 231.264)




## Commercial contract research at the FEEC in 2021

(mil. CZK, sum total 29.293)




# Commercial Contracts Research

Financial revenues from commercial contracts in 2021 were almost 30 mil. CZK, including regional research centres CVVOZE and SIX.

The research was based on both direct business contracts and students' diploma and dissertation theses.

### Numbers of final works with a topic related to industry in 2021:

| | |
|---|---|
| Bachelor theses: | 32 |
| Diploma theses: | 44 |

# Important projects

## Cybernetic network security in post quantum era (UTKO)

The project is focused on strategic long-term research and development of systems for securing modern networks.

The project will bring real data on system efficiency and readiness for securing critical communication networks, it will enable testing practical usage of QKD (i.e. quantum key distribution) and PCQ (i.e. post quantum cryptography) in real applications specific to the Czech Republic. It will also develop topics in which the Czech research is unique (e.g. optical sensors, hardware accelerated coding on speed higher than 100 Gb/s, transmissions of ultrastable quantities, etc.).

Apart from the above-mentioned key research topics the project will also focus on education and practical training of researchers, from state administration in particular.

| | |
|---|---|
| **Provider:** | TA ČR |
| **Principal investigator:** | doc. Ing. Jan Hajný, Ph.D. |
| **Start date:** | 1. 1. 2021 |
| **End date:** | 31. 12. 2025 |
| **Total funding:** | 46,735,000 CZK |


Photo: Jan Prokopius


## Research and development of detection and monitoring of people with dense coverage in shopping centers in order to optimize shopping flows and, in the event of crises and epidemics, access control to these areas (UAMT)

In 2021 a project was started, focusing on non-invasive monitoring of customers movement in densely covered areas (e.g. hypermarkets) with a possibility to guide their flow by smaller units (e.g. shops, a shopping centre, public buildings, etc.).

People are detected by a network of sensors using radar with a possibility to take 2D and 3D information. The project uses detection radar modules equipped by three transmitting and four receiving antennae.

Such configuration at a working frequency of 60 – 64 GHz allows a theoretical detection range up to 40 metres for big metal objects (e.g. cars). People and animals are detected at a 10 metres distance with a resolution of 4 mm. In the second stage, the system will be complemented by camera sensors of ToF working in IČ field which will offer invariancy in respect to lightning and, first and foremost, it will allow 3D reconstruction. As a part of the project, a subsystem for catching and analysing radio communication is being developed.

| | |
|---|---|
| **Provider:** | TA ČR |
| **Principal investigator:** | doc. Ing. Zdeněk Bradáč, Ph.D. |
| **Start date:** | 1. 1. 2021 |
| **End date:** | 31. 12. 2024 |
| **Total funding:** | 1,500,000 CZK (2021) |

## Qualitative and numerical analysis of continuous and discrete dynamical systes (UMAT)

The project focuses on research in the following areas:

- description of response of systems described by differential equations to input information provided by control functions,
- finding optimal control of systems with numerical algorithms,
- description of behaviour of systems with memory dependent on constant, state or proportional delay.

| | |
|---|---|
| **Provider:** | Brno University of Technology |
| **Principal investigator:** | doc. RNDr. Zdeněk Šmarda, CSc. |
| **Start date:** | 1. 3. 2020 |
| **End date:** | 28. 2. 2023 |
| **Total funding:** | 555,000 CZK (2021) |

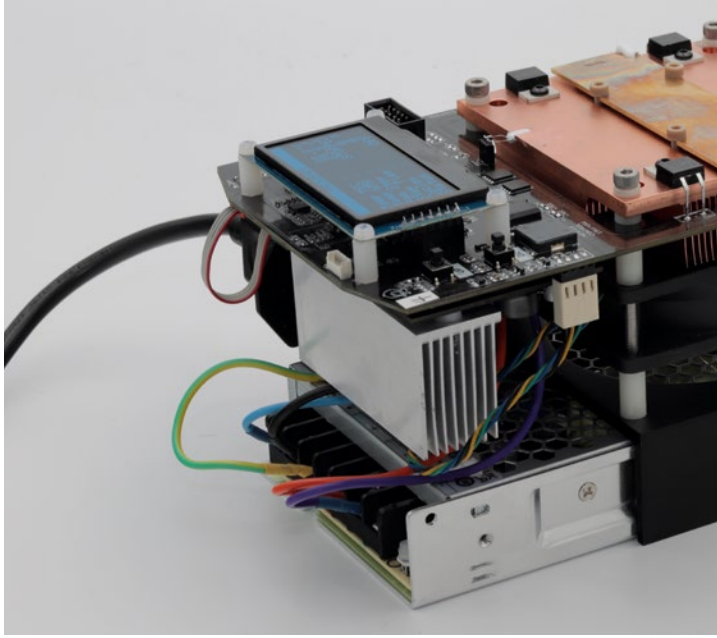
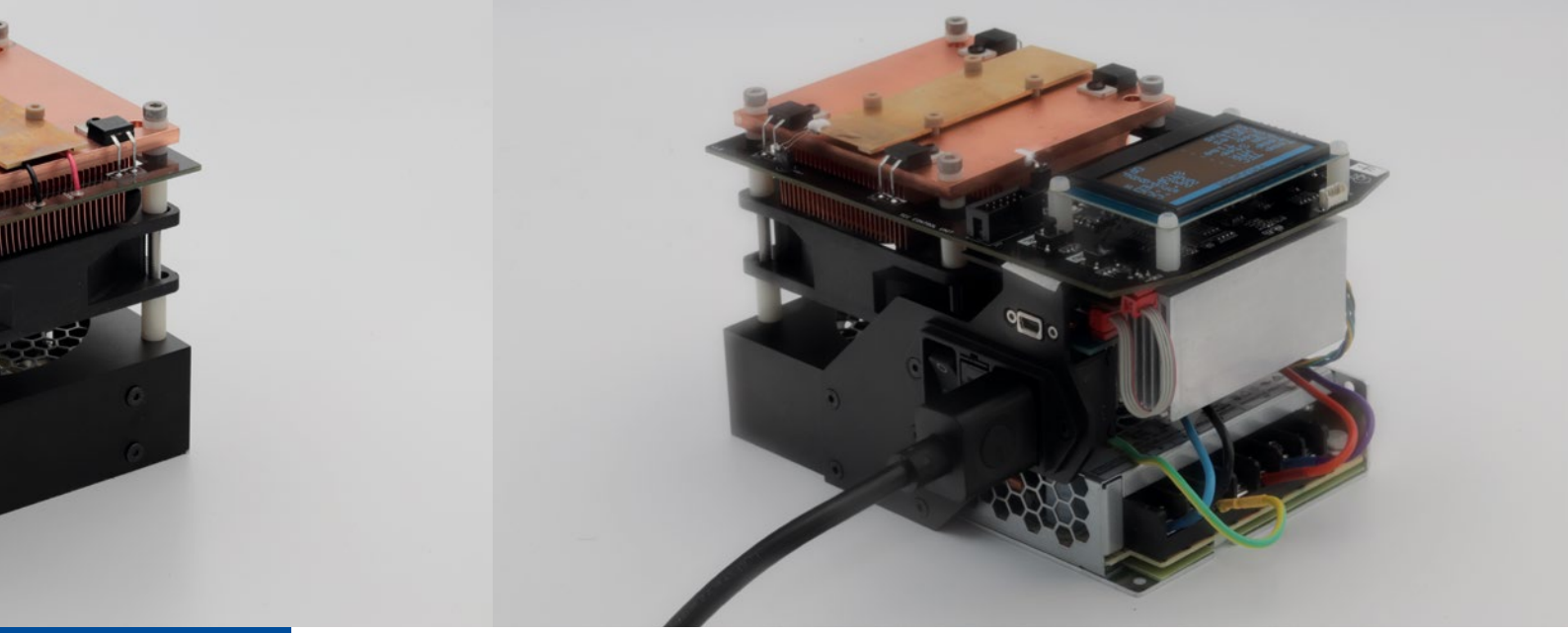


Photo: Pavel Neužil (UMEL) archive

## Modular axle computer 4.0 (UFYZ)

The aim of the project is to implement modern technology and materials based on Industry 4.0 (cyber-physical systems and IoT) principles in a modular axle computer for railway transport. The project focuses on development of cost accessible measuring points which can be integrated in current railway infrastructure and thus it can offer a competition advantage. In researching and developing implementation of cyber-physical systems into a current rail it uses modern energy harvesting and data harvesting technologies with implementation of advanced piezoelectric materials and nanotechnologies.

| | |
|---|---|
| **Provider:** | TA ČR |
| **Principal investigator:** | Ing. Pavel Tofel, Ph.D. |
| **Start date:** | 1. 1. 2021 |
| **End date:** | 31. 12. 2024 |
| **Total funding:** | 21,900,000 CZK |



## Very fast portable system for SARS-CoV-2 detection (UMEL)

The aim of the project is to develop a unique portable system for SARS-CoV-2 detection from a sample within 20 minutes, based on its specific RNA sequence. This will be enabled by a microfluid system in which a sample with a potential virus will be inserted. The sample will be automatically processed and then, amplification and detection of nucleus acids sequence detection will follow, if the sample contains the virus. Main parameters of the system are high sensitivity, small size and low production costs. Such a system can then become a common equipment for doctors and medical staff and other state security bodies. In case of pandemic similar to COVID-19, it will be possible to adapt the system for detection of other pathogens, to find quickly the source, to isolate it and thus prevent it from further spreading.

| | |
|---|---|
| **Provider:** | MV ČR |
| **Principal investigator:** | prof. Ing. Pavel Neužil, Dr., DSc. |
| **Start date:** | 1. 1. 2021 |
| **End date:** | 31. 12. 2022 |
| **Total funding:** | 14,672,224 CZK |

## Space Applications Study Programme (UREL)

The aim of the project is an accreditation and start of such master programme taught in English.
The study programme was initiated by the South Moravian Innovation Centre which runs the space incubator ESA BIC in Brno. The space incubator supports firms focusing on space applications development.

An important part of support is securing an adequate number of qualified staff and their education. The education is not only secured by companies in Brno Space Cluster, but ESA (European Space Agency) and German Centre for Aviation (DLR) promised their support as well.

Apart from UREL, the Institute of Aerospace Engineering from the Faculty of Mechanical Engineering and other FEEC departments participate at this project. A wide investigating team reflects the interdisciplinarity of space research and its applications.

| | |
|---|---|
| **Provider:** | grant Jihomoravského kraje |
| **Principal investigator:** | doc. Ing. Tomáš Götthans, Ph.D. |
| **Start date:** | 1. 9. 2021 |
| **End date:** | 1. 3. 2024 |
| **Total funding:** | 989,000 CZK |

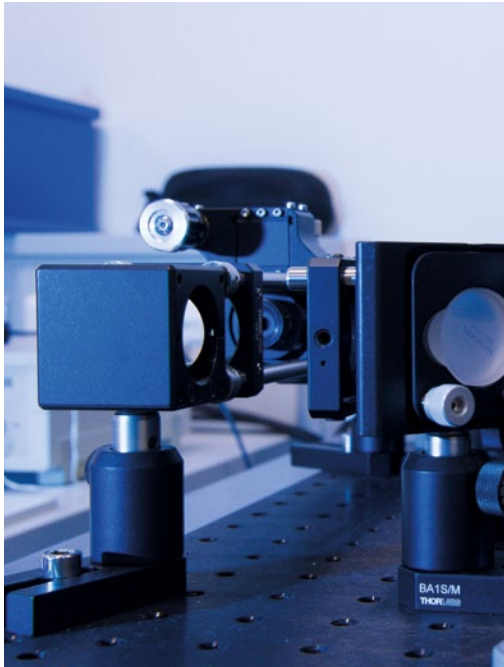


Photo: Jan Prokopius

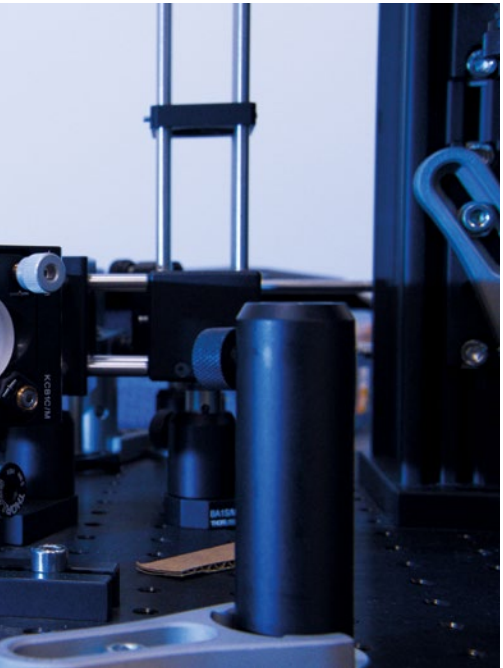


Photo: UBMI archive

## Functional retina imaging with two wave lengths and simultaneous biosignal acquisition for evaluation of eye blood circulatory system (UBMI)

Human sight is a complex process in which the key role is played by the functional eye retina. Current activities in retina imaging and evaluation are focused on metabolic retina activities during a suitable visual stimulation. This functional assessment includes evaluation of blood volume changes and changes of oxygen content in arterial and veins blood. This should be performed together, but current imaging systems do not allow it. This project uses an earlier developed video-ophthalmoscope which is in this project gradually extended by a simultaneous acquisition of retina video sequences in two wavelengths together with specific biosignals. Such complex device will bring data for a detailed analysis of metabolic retina activity with the help of advanced image processing (segmentation based on deep learning, advanced modelling and analysis of retina hemodynamic). A new methodology of retina oximetry based on pulse oximetry will be designed and tested as well.

| | |
|---|---|
| **Provider:** | GA ČR |
| **Principal investigator:** | doc. Ing. Radim Kolář, Ph.D. |
| **Start date:** | 1. 1. 2021 |
| **End date:** | 31. 12. 2023 |
| **Total funding:** | 6,147,000 CZK |

## System for sampling and detection of Coronavirus and other respiratory illnesses from the air (UTEE)

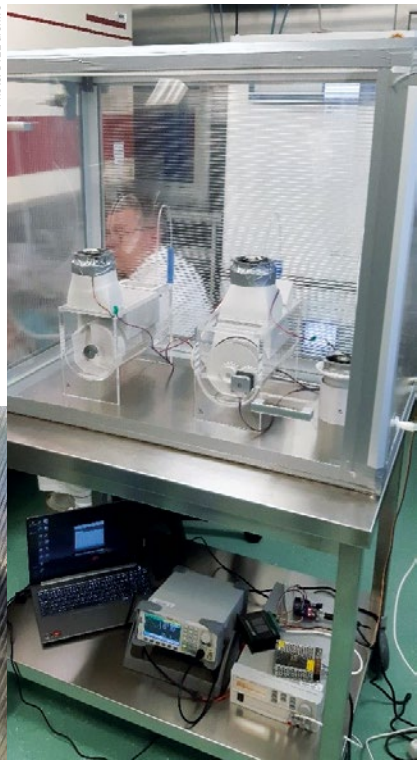
The project focuses on the development of a device capable of sampling viruses causing human respiratory infections.

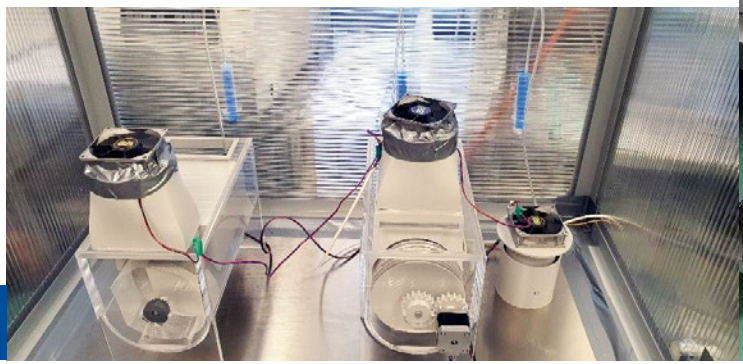
The aim of the sampling device is to monitor areas with high concentration of persons. The device will be capable of taking in the air from a room which will be drawn to the system of nano filters or to a gel surface where virus particles will be caught and detected.

In real life the detection will focus on SARS-CoV-2 virus, responsible for COVID-19 disease and other respiratory viruses with similar symptoms (e.g. influenza virus, respiratory syncytial virus, etc.).

| | |
|---|---|
| **Provider:** | TA ČR |
| **Principal investigator:** | prof. Ing. Pavel Fiala, Ph.D. |
| **Start date:** | 1. 1. 2021 |
| **End date:** | 31. 12. 2022 |
| **Total funding:** | 5,939,000 CZK |

Photo: UTEE archive





## The use of irreversible electroporation and high frequency irreversible electroporation for treatment of metal stent occlusion (UVEE)

The project cooperates with the Faculty of Medicine of the Masaryk University. It focuses on possibilities of solution of occlusion (e.g. vessel closure) of a metallic stent (i.e. a medical tool of a tubular shape planted in a body in such a way that it keeps patency of the tubular structure) with the help of non-thermal ablation techniques (irreversible electroporation and high-frequency irreversible electroporation) applied on numerous hydrogel ex vivo tissue models. Histopathology analysis of tissue models after ablation and measurement of tissues models properties will be compared to computer simulations of electric field, thermal changes and extent of ablation. The aim of the project is to establish methodology for recanalization of occluded metal stents in clinical practice.

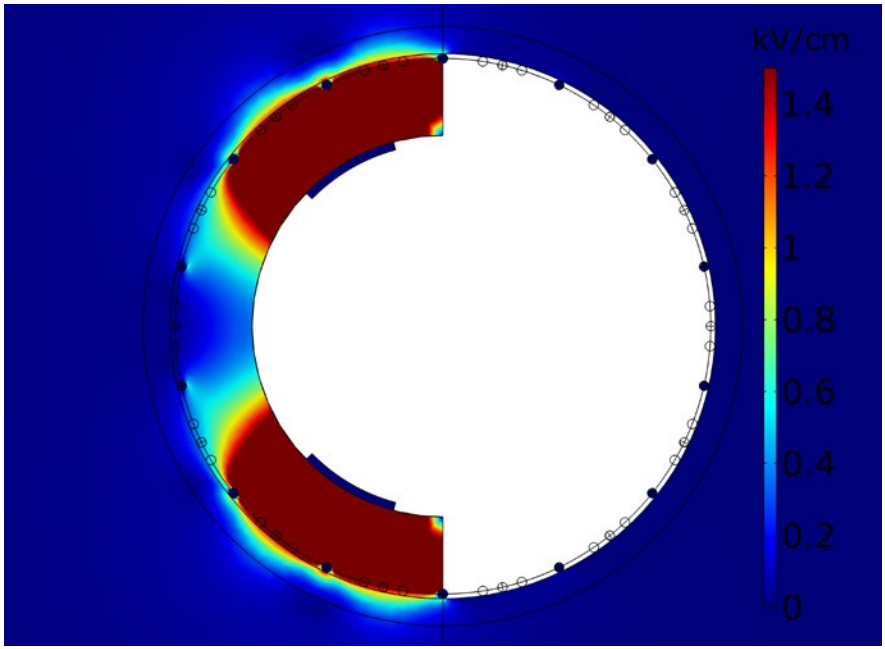



Photo: UVEE archive

**Intensity of an electric field around electrodes at 1,300 V in a tissue model.**

| | |
|---|---|
| **Provider:** | MZ ČR (Ministry of Health) |
| **Principal investigator:** | prof. RNDr. Vladimír Aubrecht, CSc. |
| **Start date:** | 1. 5. 2021 |
| **End date:** | 31. 12. 2024 |
| **Total funding:** | approx. 11,000,000 CZK |

## System for disability glare evaluation of lighting systems powered from public electrical grid (UEEN)

The aim of the project is to develop a measuring system for evaluation of street lights from the perspective of lightning parameters and lights glare from the installed road lights approved by ČSN EN 13 201. The aim of the evaluation is to analyse brightness and contrast ratio in the streets.
The measuring apparatus uses a current LDA – LumiDISP glare analyser which is based on a commercially accessible camera spectrally adapted and complemented with evaluation software which can analyse an imaging scene.

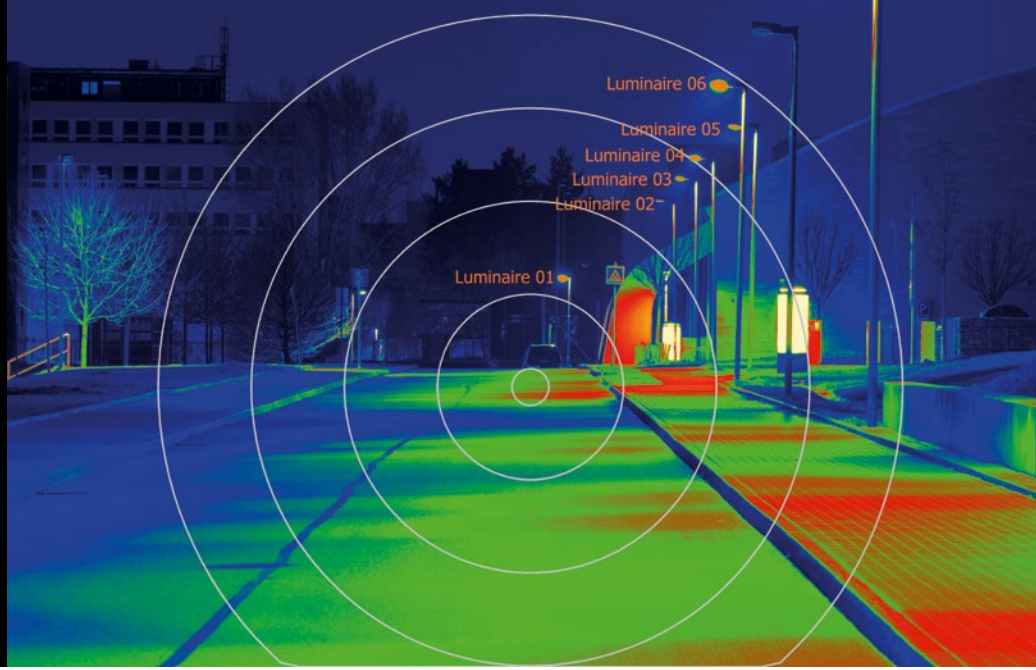
The measuring glare itself is based on measuring the so-called threshold increment which is directly connected with veiling brightness amount.
This is created by glaring lights and it appears in an observer's eye as a mist over a scene due to light dispersion. Due to this fact, a contrast between environment and an obstacle in the road decreases and thus decreases visibility and differentiation for a driver. An absolute glare level for which eyesight is adapted also plays some role in visibility. Nowadays, street lightning is being renewed and it is usually co-financed by state dotation which tries to use electricity needed for lightning systems effectively. Nowadays, providers and investigators of projects on street lightning renewal focus on numeral parameters at a road fulfilment which can be tested by modern technologies, but glare by installed road lights is not measured that easily. It usually relies on theoretical computations which cannot often reflect the current state of things and the result is often on the requested limit and sometimes over the requested limit.

Thus, the resulted lightning system can sometimes be more effective from the point of electricity consumption, but from the point of functionality it can be unsatisfactory. Thanks to the above-mentioned device it will be possible to identify such lightning systems more easily and to improve them, which will result in a functional and more effective lightning system. As a side effect, an increase in security at the roads will follow, as glaring lightning system disturbs a driver who can overlook an obstacle or so.

Photo: UEEN archive

**Set of a current brightness glare analyser LDA – LumiDISP.**

| | |
|---|---|
| **Provider:** | TA ČR |
| **Principal investigator:** | Ing. Jan Škoda, Ph.D. |
| **Start date:** | 1. 7. 2020 |
| **End date:** | 30. 6. 2023 |
| **Total funding:** | approx. 7,800,000 CZK |


An example of glare analysis at the roads (lightning identification).

## Research and development of measuring probes and units in well-logging (UETE)

During 2021 a TAČR TREND: Research and development of measuring probes and units in well-logging was solved. It focuses on a geophysical method on well profile determination.

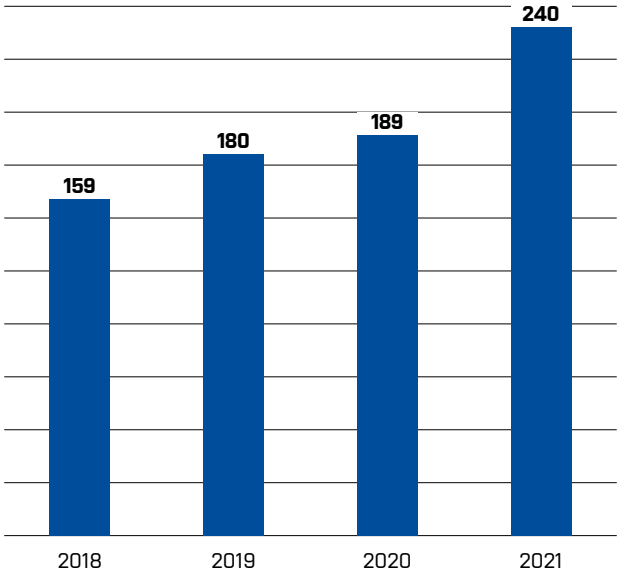
The project runs in cooperation with a world-famous company making well-logging probes of a small size. The first year out of the three-year project dealt with design and creation of a prototype of an inclinometer measuring well deviation from the perpendicular and its direction in space towards the Earth pole. The design started with a PCB design, mounting, probe programme equipment and it was finalized with a laboratory probe testing.

| | |
|---|---|
| **Provider:** | TA ČR |
| **Principal investigator:** | Ing. Josef Máca, Ph.D. |
| **Start date:** | 1. 1. 2021 |
| **End date:** | 31. 12. 2023 |
| **Total funding:** | 13,933,000 CZK |

# PUBLICATIONS

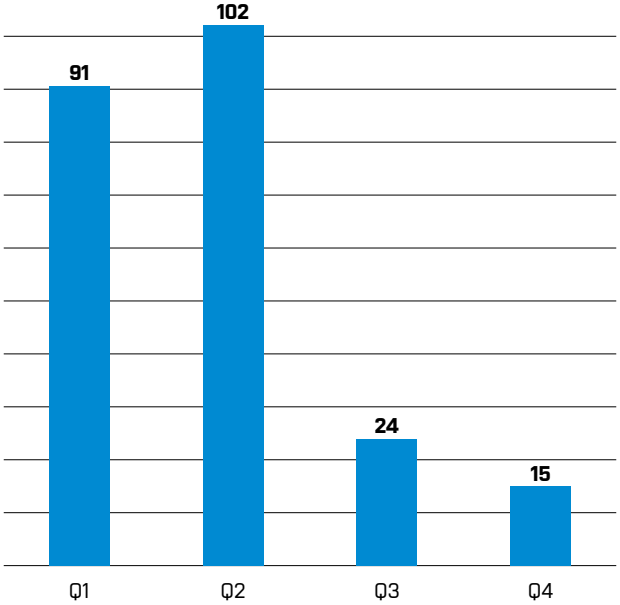
### Number of WoS journal publications

(Without quartile specification)




### FEEC publication profile in 2021

(Number of WoS journal papers)




Note: unsorted publications (8 pcs) not included

**9**
**books or book chapters**

**276**
**papers in Web of Science Core Collection (WoS)**

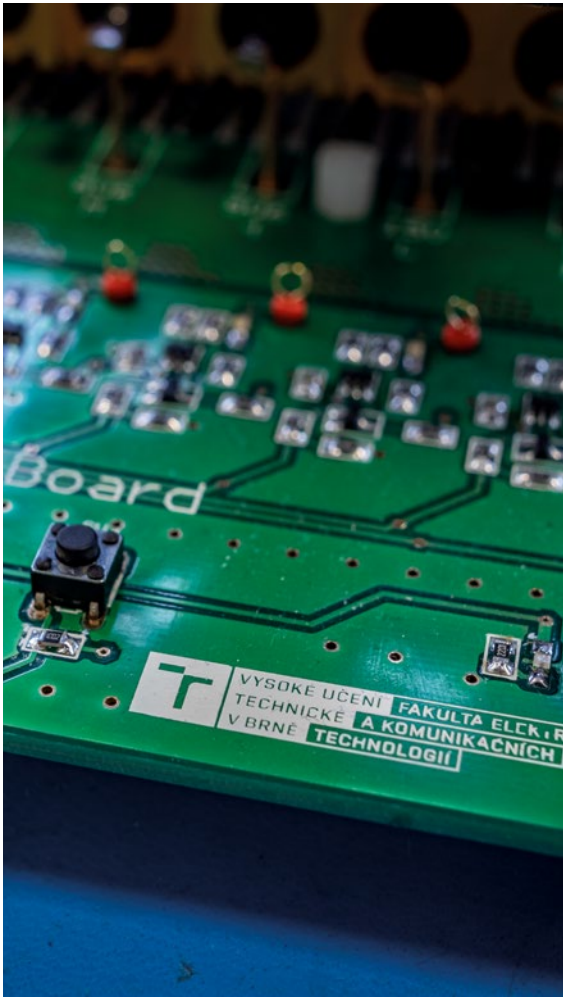
**210**
**conference proceedings indexed by WoS or Scopus**

**68**
**prototypes, software or functioning samples**

## Utility models in 2021

- PLC module for electric plugs and electric plugs containing them
- System for mapping an active fire site by unmanned aerial vehicle
- System for a certification of electric power sources plugged in electric network of low voltage
- Control device for manipulation with 3D objects and models of electronic devices, in virtual and augmented reality in particular

Photo: Jakub Rozboud



# FEEC DEPARTMENTS AND RESEARCH CENTERS

## Department of Control and Instrumentation (UAMT)

Department of Control and Instrumentation focuses on instruction, research and development in control, measurement, industry automatization, artificial intelligence, robotics and computer vision. In 2021, during the Covid time, it provided instruction at full scale in the bachelor study programme Automation and Measurement and in master and doctoral study programmes. In control measurement the department focused mainly algorithms of predictive electric drive control and their computationally effective implementation in electric driven control systems and methods of electric drives diagnostics using AI. Advanced methods of dynamic systems identification were also studied. Activities in control measurement focused on the issue of electrical and electronic measurement, virtual instrumentation in LabVIEW, sensors and measurement methods and evaluation of nonelectric quantities related to vibrodiagnostics, thermodiagnotics, acoustic emissions, flow measurement, etc. Industry automatization activities were aimed at Industry 4.0, in-built real time systems, wireless communication systems and industrial Ethernet with focus on functional security and safeguarding against inner and outer faults and attacks. Newly in 2021, a laboratory for teaching Industry 4.0 technology was made. The research in computer vision continued with development of industrial, transportation and medical systems. Newly, it also dealt with Industry 4.0 related topics, such as encoder design for autonomous industrial inspection and machine learning use for planning transportation flows. In research, which is part of the National Cybernetics Centre, a universal inspection software system Anubis was developed, which is intended for industrial tasks. A group of researchers focusing on robotics and AI dealt with further development of ATEROS system (autonomous telepresentation robotic system) aiming at higher autonomy of the so-called mapping missions. The main goal is to achieve precise photogrammetric maps from drones using RTK GNSS and maps showing radiation in areas of interest.

Photo: UAMT archive

| | |
|---|---|
| **Head:** | doc. Ing. Václav Jirsík, CSc. |
| **Number of research tems:** | 5 |
| **Number of employees (recalculated):** | 26.57 |
| **Average age of employees:** | 45.29 years |
| **Ratio of women employees:** | 8.5 % |

Photo: UBMI archive, Jan Prokopius


# Department of Biomedical Engineering (UBMI)

In 2021, the Department of Biomedical Engineering continued in innovations of instruction and research-oriented laboratories, in particular on the laboratory of movement analysis, created together with the Centre of Sport Activities. The laboratory enables complex study of relations between movement patterns, muscle activity and working with the centre of the body during sporting tasks and rehabilitations. Furthermore, vast innovations of laboratories focusing on cell and tissue research and laboratories for the research of genomics and proteomics were finished.

They included 3D bioprint or sequencers of a new generation. The department included teaching several English subjects for international students related to medical signal and image processing, cell biology and AI. Another important activity was organizing an important conference on Computing in Cardiology, which hosted scientists and researchers from all over the world.

| | |
|---|---|
| **Head:** | prof. Ing. Ivo Provazník, Ph.D. |
| **Number of research tems:** | 9 |
| **Number of employees (recalculated):** | 30.04 |
| **Average age of employees:** | 39.53 years |
| **Ratio of women employees:** | 37.8 % |

Photo: UEEN archive


# Department of Electrical Power Engineering (UEEN)

The department practises instruction in power electrical engineering in bachelor, master and doctoral study programmes. To support instruction in power electrical engineering and communication technology, the department managed to obtain a financial donation of 2.3 mil. CZK for scholarships and laboratory equipment. Petr Toman and Jiří Drápela were appointed professors in Power Electrical and Electronic Engineering in 2021. Research of the department deals with production, transmission, distribution and usage of electric power. Among the most important activities solved in 2021 were failure localisation in electric grids, checking compliance of manufacturers with electric grids, testing and optimisation of switches for connection of diffused energy sources, research of accelerator-controlled nuclear reactors and brightness analysis performance. The department also managed to buy a three-phase power source, Regatron amplifier, for amplifying low-level signals from an external device (a real-time simulator) to a low voltage network, at the output of 50 kVA. A power source interface can be connected to a tested device, e. g. a photovoltaic switch. Such method can interactively help students to understand better grids with an implanted production which will be used more and more, in compliance with the new energy concept.

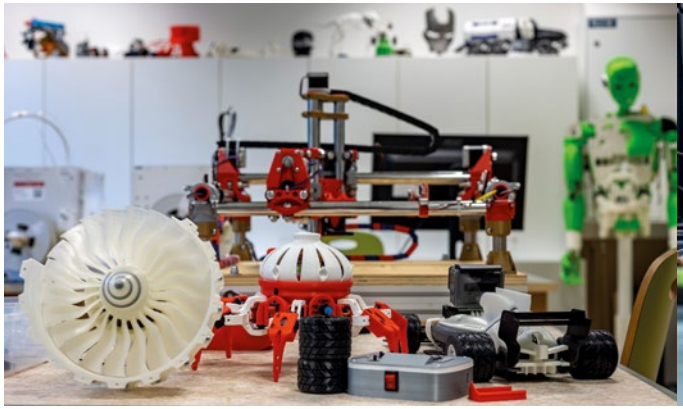
| | |
|---|---|
| **Head:** | prof. Ing. Petr Toman, Ph.D. |
| **Number of research tems:** | 8 |
| **Number of employees (recalculated):** | 33.51 |
| **Average age of employees:** | 38.25 years |
| **Ratio of women employees:** | 18.8 % |

# Department of Electrical and Electronic Technology (UETE)

Department of Electrical and Electronic Technology provides instruction in courses related to electro technical materials, their manufacturing processes, diagnostics, testing engineering, management and quality control. Most first year students in the newly accredited bachelor study programmes are taught subjects of Technical Documentation, Materials for Electrical Engineering, and Introduction to Materials for Electrical Engineering. The department, together with the Department of Microelectronics, provides instruction in a bachelor study programme Microelectronic and Technology, and it teaches on its own Electrical Engineering Production and Management in a master study programme. In cooperation with the Department of Microelectronics and the Department of Physics it teaches doctoral study programme called Microelectronics and Technology. Apart from material-oriented subjects the department also provides instruction on subjects oriented at alternative energy sources and ecology. The department deals with electron microscopy, photovoltaics and electrochemical current sources. In electrochemical sources the department continued its design and development of new materials in Li-Ion batteries, electrocatalysts and ion change membranes for fuel elements. Regarding photovoltaic systems the department studied the issue of non-destructive diagnostics of defects and quality, reliability and service life of solar cells. The department was developing a system of detection of signal electrons and methods of environmental rastering electron microscopy and microscopy of atomic powers for the use in electron microscopy.

| | |
|---|---|
| **Head:** | doc. Ing. Petr Bača, Ph.D. |
| **Number of research tems:** | 5 |
| **Number of employees (recalculated):** | 24.73 |
| **Average age of employees:** | 45.5 years |
| **Ratio of women employees:** | 23.7 % |

Photo: Jakub Rozboud

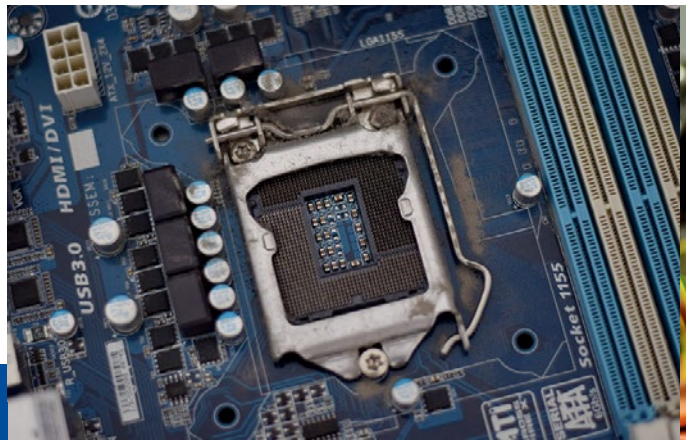


# Department of Physics (UFYZ)

In its educational activities the department provides instruction of basic courses in physics in bachelor and follow-up master studies.
The Department of Physics guarantees instruction in courses 'Nanotechnology', 'Modern Physics', 'Solid State Physics', 'Non-Destructive Diagnostics and Physics of Dielectrics' and 'Physical Optics'.
In doctoral studies it provides instruction in courses 'Junctions and nanostructures', 'Spectroscopic methods for non-destructive diagnostics' (for FEEC) and 'Optics' (for FIT).

In research, the department focused on basic and applied research of physical parameters of semiconductor and dielectrical materials and components and on Nano sensorics. The main areas included mechanical transportation of electric charge, noise spectroscopy, local characterization with nanoresolution, and designing indicators of quality and reliability of components. Other research focuses on methods of acoustic and electromagnetic emission. The department also cooperates with industrial partners on manufacturing a device controlling and checking manufacturing processes. In 2021 the department helped with solving several economy contracts with Czech and foreign institutions. The largest and most important project is realisation of cryogen models of semiconductor structures for Semiconductor Components Industries, LLC. Within the ranges of the Czech Republic, the department cooperates in the long run with the Smurfit Kappa s.r.o. company on an automatized system of manufacturing tolerance validation and on cardboard loading.

| | |
|---|---|
| **Head:** | doc. Ing. Vladimír Holcman, Ph.D. |
| **Number of research tems:** | 3 |
| **Number of employees (recalculated):** | 21.85 |
| **Average age of employees:** | 44.75 years |
| **Ratio of women employees:** | 20 % |



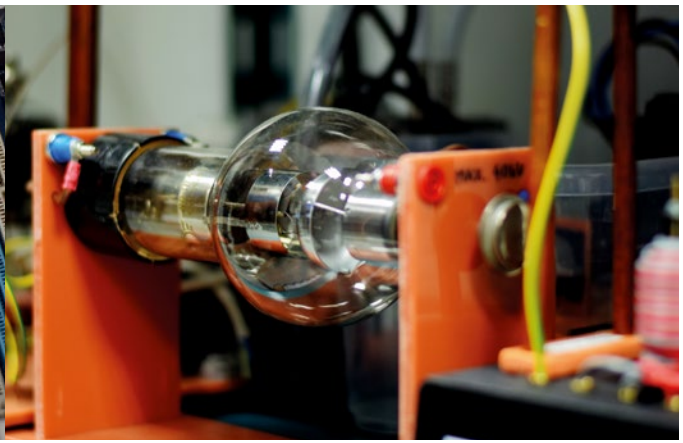



Photo: Oto Janoušek

Photo: Jakub Rozboud

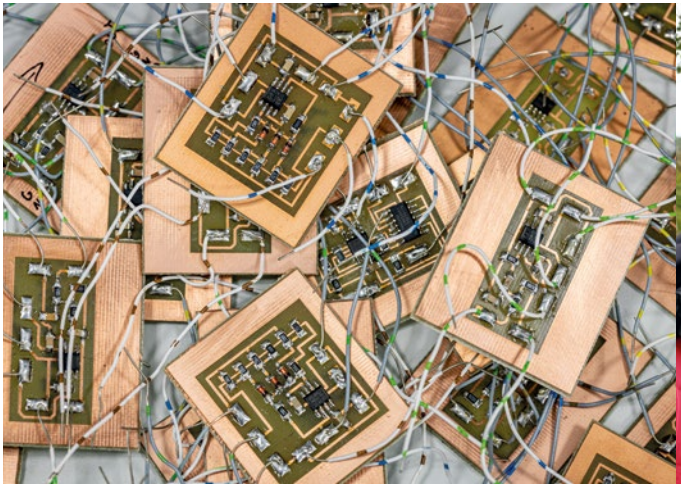


Photo: UJAZ archive

# Department of Languages (UJAZ)

In 2021, Department of Languages provided and guaranteed linguistic and popular sciences courses at the bachelor, follow-up master and doctoral levels at three faculties of BUT: the Faculty of Electrical Engineering and Communications, the Faculty of Business and Management and the Faculty of Information Technology. In the study programme English in Electrical Engineering (AJEI-H), guaranteed by the department, 20 students successfully passed their final state exams. The study programme provides its graduates with skills and competences useful for experts in numerous specializations of electrical engineering and information technology. Apart from instruction in its own study programme, the department continued to offer courses for all other technical bachelor, master and doctoral study programmes of three faculties. It has been the second year of teaching Czech for foreigners, which helped Erasmus and foreign students of master and doctoral study programme to accustom to life in the Czech environment.

Apart from the prevailing professional language instruction, the department offers optional subjects from law and economy (accounting, taxes, financial services), psychology, pedagogy or soft skills. Students can also acquire, after completing an accredited supplementary pedagogical study (new accreditation valid till 2023), a Certificate of Pedagogical Competence enabling its graduates to perform pedagogical activities at all secondary schools in the Czech Republic.

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| **Head:** | Ing. Martin Jílek |
| **Number of research tems:** | 3 |
| **Number of employees (recalculated):** | 18.90 |
| **Average age of employees:** | 51.1 years |
| **Ratio of women employees:** | 76.2 % |

Photo: Karolina Grabowska z Pixabay

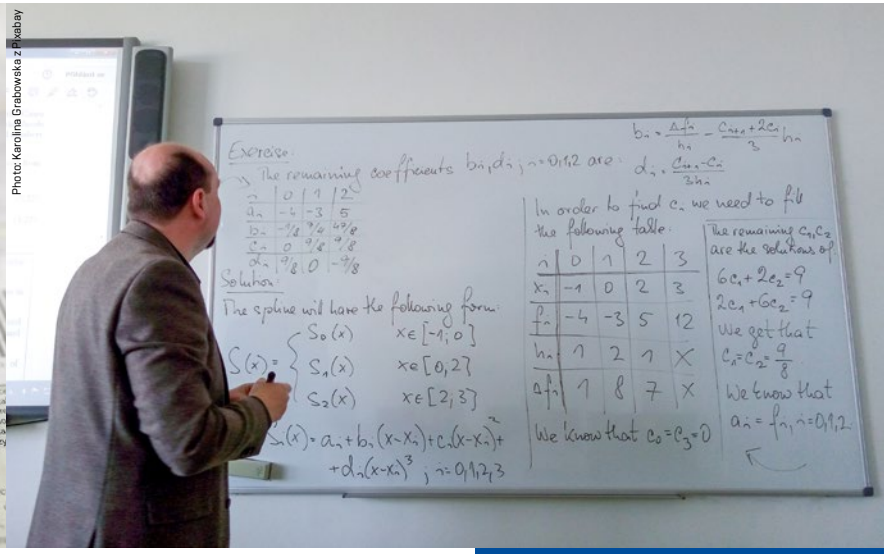


Photo: UMAT archive

# Department of Mathematics (UMAT)

The department provides instruction of mathematical courses not only to the FEEC, but also to the Faculty of Information Technology, Centre of Sports Activities and the Institute of Forensic Engineering. At the FEEC in 2021, the department provided mathematical courses in all types of study programmes. Scientific research at the department focused on three research groups: dynamic systems, algebra and discreet mathematics, and statistical methods. In 2021, all three groups were cooperating with foreign and Czech institutions and important world mathematicians. A cooperation with the Serbian Academy of Science in Belgrade, and universities in Beer Sheva or Kyiv resulted into interesting results in dynamic systems and numerical methods solutions, automatization tasks, signal and image processing and many other. In cooperation with Transport Research Centre the department solved problems related to autonomous cars trajectories. The department research in censored divisions and extreme values resulted into a cooperation with the Institute of Forensic Engineering on solving problems in real estate evaluation.

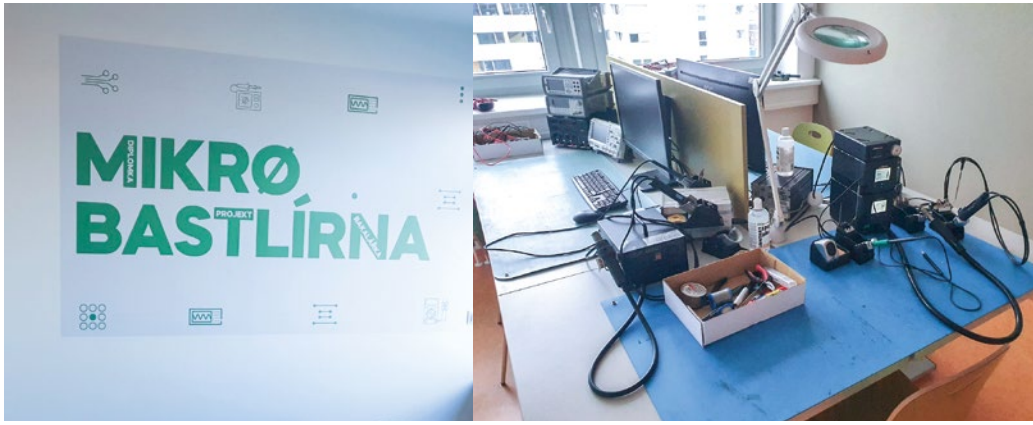
| | |
|---|---|
| **Head:** | doc. RNDr. Michal Novák, Ph.D. |
| **Number of research tems:** | 3 |
| **Počet zaměstnanců přepočtený):** | 13.94 |
| **Average age of employees:** | 53.38 years |
| **Ratio of women employees:** | 26.3 % |

# Department of Microelectronics (UMEL)

Despite ongoing restrictions and limitation due to COVID-19 pandemic, the department successfully realized both online and attended instruction in its study programmes. Despite initial concerns about keeping good quality instruction online, most students of all study programmes successfully passed the final examinations where high standards of knowledge were requested. During online lessons, quite a lot of interactive materials were created, which helped largely to these positive results.

In scientific field, the department practised applied research in integrated circuits, special electronic systems, sensors and micro/nanotechnologies. Main areas of focus included methods of circuit design in voltage, current and mixed mode, systems for space applications or complex Smart systems, MEMS and NEMS structures. Many solved projects and direct contractual orders dealt with up-to-date topics such as smart access systems, meteo-satellites electronics, fast COVID-19 detection or ecological handling of electrical engineering materials.
At the department, they opened a new research laboratory for students who enjoy creating devices for their scientific research thesis, e.g. Mikrobastlírna, as the laboratory is nicknamed, is open to all students of study programmes guaranteed by the UMEL 24/7, thanks to the chip card access and full-time surveillance. Students can use all devices and technological equipment necessary for their creative work. Great thanks belong to the department partner onsemi which supplied a great number of components and material worth of almost 200,000 CZK. All the laboratory foundation cost about 150,000 CZK. We strongly believe that the laboratory will help in further professional career growth of our students. In 2021 the representatives of the department also participated at the traditional Meeting of microelectronics departments which was organized by the Institute of Electronics and Photonics at the Faculty of Electrical Engineering at the Slovak University of Technology (STU) in Bratislava.

Photo: UMEL archive




| | |
|---|---|
| **Head:** | doc. Ing. Jiří Háze, Ph.D. |
| **Number of research tems:** | 4 |
| **Number of employees (recalculated):** | 23.45 |
| **Average age of employees:** | 45.26 years |
| **Ratio of women employees:** | 16 % |

# Department of Radioelectronics (UREL)

UREL dedicates to research, development and instruction in wireless systems and related fields.

Among main application areas you can find communication, sensing, location and navigation. Based on their frequency, applications are divided into low frequency (sensing and processing of biological signals), millimetre waves (local wireless systems for ISM band of 60 GHz) and optical frequency (optical communication in free space). Attention is given to system view (television and multimedia systems, electromagnetic compatibility) and partial subsystems (electronic circuits, signal processing, antennae and microwave structures).

Nowadays, the department focuses mainly on space applications. The research participates at the construction of a nano-satellite BDSAT and at the development of a compact bidirectional amplifier for remotely controlled aerial vehicles for the European Space Agency. Apart from that, the department provides instruction in this field.

In 2021, in cooperation with the Institute of Aerospace Engineering at the Faculty of Mechanical Engineering, a new master study programme in English, Space Applications, was accredited and it will be opened for enrolment in 2022/23 academic year.

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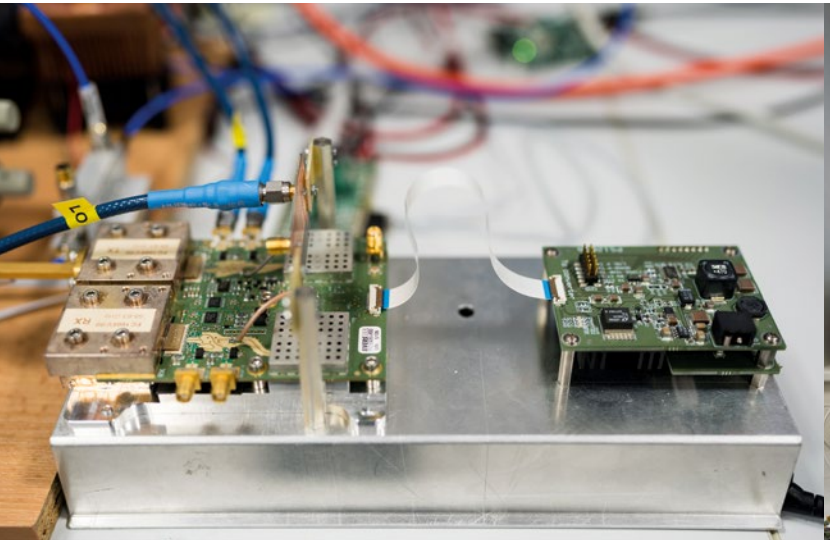
|---|---|
| **Head:** | prof. Dr. Ing. Zbyněk Raida |
| **Number of research tems:** | 6 |
| **Number of employees (recalculated):** | 43.70 |
| **Average age of employees:** | 43.27 years |
| **Ratio of women employees:** | 14.3 % |



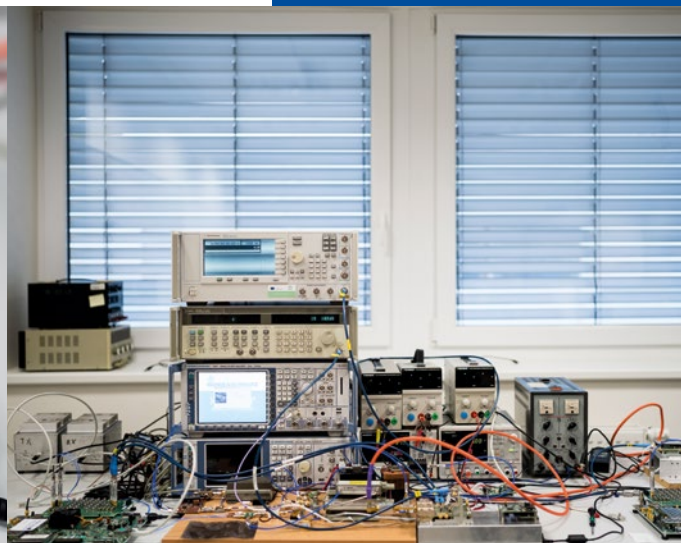


Photo: Jan Prokopius

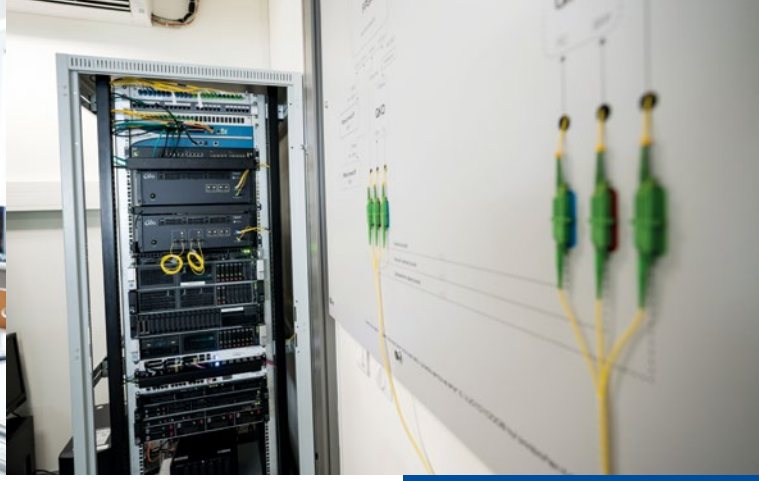


Photo: Jan Prokopius

# Department of Telecommunications (UTKO)

The Department of Telecommunications excels in information and communication technologies, in particular in 5G high speed networks, communication in industrial networks and power engineering, cybersecurity, large amount of data processing, artificial intelligence and last but not least, image and sound processing. It strives in the long run to be an excellent research and educational workplace. It guarantees 3 bachelor, 4 master and 4 doctoral study programmes. As far as the research and development are concerned, in 2021 the department participated at the solution of more than 50 research projects with important national and international companies working in ICT. During 2021 two new excellently equipped laboratories were opened:

Vodafone UniLab laboratory is a place where companies can easily test their existing products or try out newly created ideas in the form of a prototype or experimental measuring. The main aim of the laboratory is to join academic world with industrial partners and, to offer a newly equipped environment for testing and development of devices for IoT or Industry 4.0. Quantum security laboratory will allow scientists to work at computer networks of a new generation. Special laboratory equipment is intended for our experts for research in sensitive data protection, especially against quantum computer attacks for which a current level of security would be an easily overcome obstacle. When breaking into the data, state security or critical infrastructure could be threatened.

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| **Head:** | prof. Ing. Jiří Mišurec, CSc. |
| **Number of research tems:** | 8 |
| **Number of employees (recalculated):** | 84.56 |
| **Average age of employees:** | 37.9 years |
| **Ratio of women employees:** | 10.1 % |

# Department of Theoretical and Experimental Electrical Engineering (UTEE)

The department research focuses on three main areas:

Use of numerical methods for modelling physical fields, nanotechnology engineering in organics and inorganics, basic elements of mass, plasma research and its parametric generation,

research into special measurement methods including techniques of nuclear magnetic resonance (NMR) and nuclear quadrupole resonance (NQR),

research area of experimental and applied electrical engineering and electronics focusing on detection of short, high power electromagnetic impulses (up to 10 GW), fast repeated as well as single processes (in ns) and non-standard sources of electric energy and unmanned aerial vehicles.

In 2021 UTEE and UAMT together with the Faculty of Military Technology of the University of Defence prepared an Artificial Intelligence-Controlled Robotic System for Intelligence and Reconnaissance Operations. It also develops new devices for assessment of surface conditions in cave environment together with the Faculty of Natural Sciences of the Masaryk University. In cooperation with ENBRA, a.s. it is developing testing devices for measuring a flow of heating and water, and a system of shooing of starlings based on passive optical locator.

At the UTEE, during 2021, a new laboratory was made for unmanned aerial vehicles and sensorics for research in a newly acquired project. A new subject 'Unmanned aerial vehicles' was included in instruction.

Photo: UTEE archive

| | |
|---|---|
| **Head:** | prof. Ing. Pavel Fiala, Ph.D. |
| **Number of research tems:** | 7 |
| **Number of employees (recalculated):** | 21.23 |
| **Average age of employees:** | 44.1 years |
| **Ratio of women employees:** | 22.2 % |

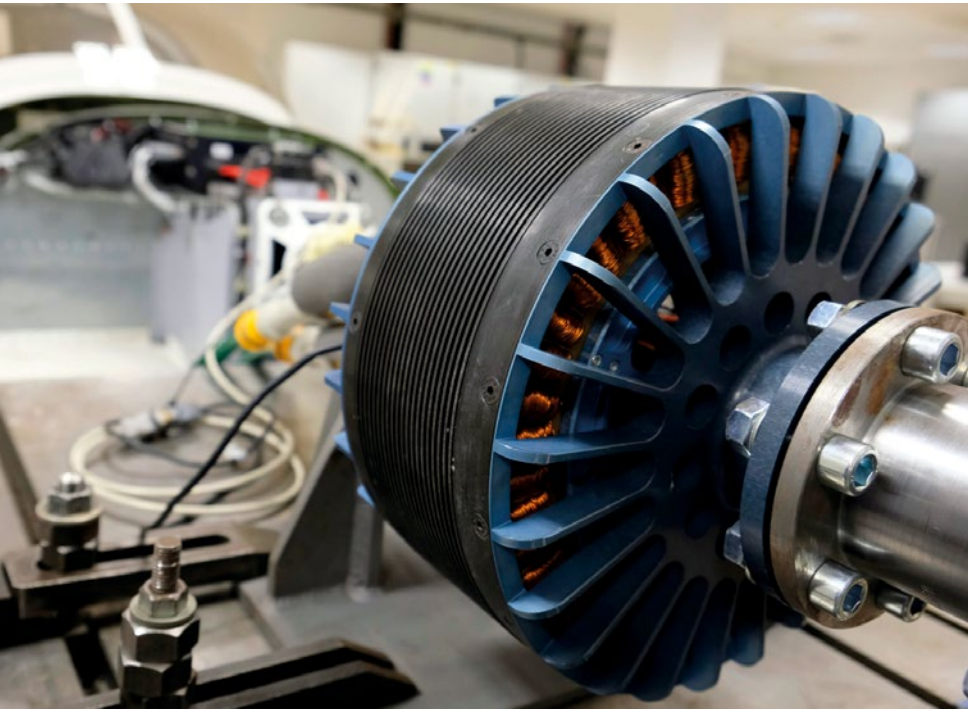

Photo: Jan Bárta

# Department of Power Electrical and Electronic Engineering (UVEE)

In 2021, UTEE strengthened the cooperation with the University of Johannes Kepler University in Linz. There were many internships for students as well as employees at their university. Next year employees will actively start cooperation with the Austrian K2 Research Centre. In power electrical engineering electronics, the development of a three-phase generator of an artificial power network was finished and they are still developing a multilevel DC/AC switch of 300 kW. Model-oriented control algorithms were newly implemented in the development. Further, they were developing a special topology of a three-phase single-stage PFC with galvanic division. In electric drives they were focusing on the development of alternating drives with respect to maximum efficiency and mathematical modelling of five-phase synchronous engine with a PM. In the field of electric machines, the research and development focused on high-revolution engines, in particular on engine for cooling circuits of fusion reactors (10 MW), on the engine for a turbo compressor and newly on a generator for cryogen turbo expander. One-phase and three-phase engines for a direct connection to the grid were also being developed, together with the development of electromechanical actuators for controlling primary control surface of CS-23 category airplanes and for Urban Air Mobility vehicles.

They also cooperated with several industrial partners focusing on the development of machines key parts and a diagnostic of a switch arc.

| | |
|---|---|
| **Head:** | doc. Ing. Ondřej Vítek, Ph.D. |
| **Number of research tems:** | 8 |
| **Number of employees (recalculated):** | 33 |
| **Average age of employees:** | 40.33 years |
| **Ratio of women employees:** | 7.3 % |

Photo: Jana Valchová

## Centre for Research and Utilization of Renewable Energy Sources (CVVOZE)

CVVOZE focuses its research, developmental and innovation capacities on solving a complex problem of renewable sources of energy. Its research teams deal with problems in chemical, and photovoltaic energy sources, electromechanics, electric drives, power electrical engineering, nuclear power plants and industrial electronics in 5 main research areas: optimization of electromechanics energy transformation, chemical and photovoltaic energy sources, production, transmission, distribution and usage of electric energy, automatization and sensorics technologies, and research in switching-off mechanism in switching-on devices.

In 2021 the centre published 28 journal articles with impact factor based on the Web of Science. The centre realized 30 projects of applied research in cooperation with industrial sector partners (TA ČR and MPO projects). Among important projects supported by TA ČR we can list e.g. TK01030094 – Smart Energy Network, TK02030013 – Cyber-physical twin of tomorrow's municipal infrastructure or TK02030119 – Technology of high revolution systems for use in thermonuclear fusion.

Another great centre's success is winning almost 17 mil. CZK in contractual research for industrial companies, which accounts for 57 % of all non-public finances from contractual research at the faculty.

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| **Head:** | prof. RNDr. Vladimír Aubrecht, CSc. |

# Centre of Sensor, Information and Communication Systems (SIX)

SIX Centre started in 2010 as a common initiative of FEEC BUT departments engaging in research and development of sensorics systems and information and communication technologies. The aim of the initiative was to interconnect departments' common research interests to create vast complex research projects.

In recent years the growth of activities connecting academic and industrial sphere is more and more explicit and there is an increase in demand for professional and practical activities of the SIX, which is also reflected in high number of contractual research orders realized in 2021 cooperating with industrial partners. This represents 35 % share of all non-public finances from the contractual research at the FEEC. It is thus obvious that SIX Centre fulfils its set goals and it represents a role of a recognized regional development centre.

This year, SIX staff had no exception in limitations caused by the COVID-19 pandemic, which was reflected mostly in holding professional seminars or negotiations with industrial partners.

Thanks to high work enthusiasm of centre workers neither running projects nor set deadlines in industrial orders were influenced by that.

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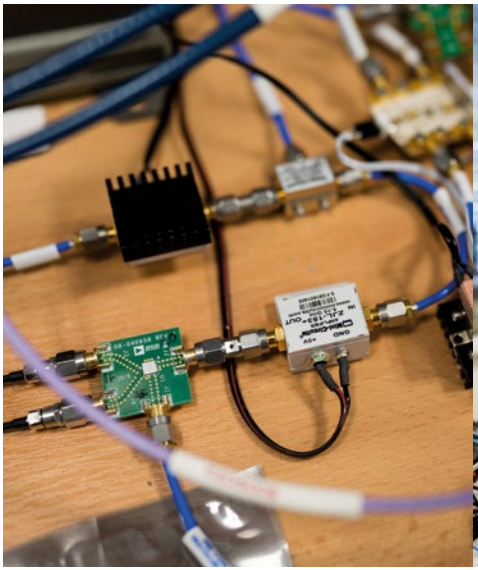
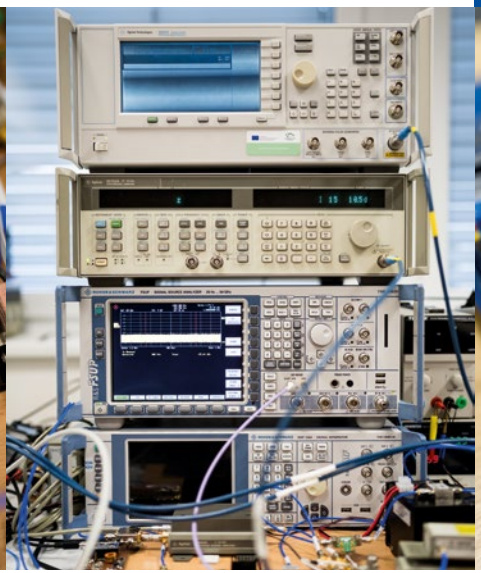
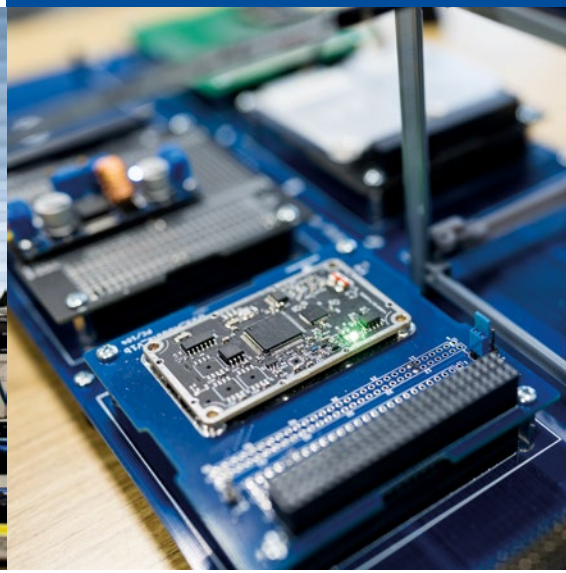
| **Head:** | prof. RNDr. Vladimír Aubrecht, CSc. |

Photo: Jan Prokopius







# SOME HISTORY


Photo: Jakub Rozboud

Faculty of Electrical Engineering and Communication is, and has always been, an integral part of Brno University of Technology, that is why its history is firmly joined together. It is a history full of renaming, dividing, joining and moving all around Brno. Nevertheless, all this made FEEC what it is now and it is worth refreshing it.

Brno University of Technology was founded on 24 January 1849 when the Moravian Diet approved foundation of a technical school. The school was bilingual with languages of instruction both Czech and German. Its students could study technical, agricultural and commercial areas. Due to the course of history, however, Czech language gradually disappeared, that is why in 1899 Czech Technical University was founded. After the First World War it was united with German Technical University and thus originated the Technical University in Brno.
On 24 July 1956 Brno University of Technology was founded with three faculties: Faculty of Construction

Engineering (FCE), Faculty of Architecture and Building Construction (FABC) and Faculty of Energy (FE). The Government Act no. 58 of 12 August 1959 divided the Faculty of Energy into Faculty of Mechanical Engineering and Faculty of Electrical Engineering. This is the beginning of an independent electrical engineering faculty in Brno. In 2002 an independent Faculty of Information Technology (FIT) was established and the original Faculty of Electrical Engineering and Information Technology was transformed into the current Faculty of Electrical Engineering and Communication (FEEC) on 1 January 2002.

Photo: Jakub Rozboud

# LIFE AT FEEC


Photo: Jakub Rozboud

## PerFEECt mer[č]

During 2021 new faculty promotional products were being created, which was also helped by students themselves. Promotional products are intended for students. The old faculty logo was revived to be used as a student club symbol. New graphical designs for a glass bottle in thermo jacket, a tin can, a T-shirt, a sweatshirt and socks were created based on survey. A new version of a pin badge in a lapel and a key chain originated as well. The range of products grows, as an example we can name the sweatshirt with graphical design or mouse mats designed by students. The sale was started at the beginning of the winter semester 2022 and the products can be bought in the library at Technická 12. Current offer can be found at the faculty website.

# PerFEECt year 2021

During the year, many conferences, competitions for students or events for staff and general public are organized or co-organized frequently. Unfortunately, most events, together with instruction, were impacted heavily by the COVID-19 pandemic. Some events were held online, other were cancelled. Despite the adversities, many events took place.

## JANUARY

### 27.

### Online Open Doors Day for prospective students

Photo: Jana Valchová

Unfortunately, the situation at the faculty did not allow holding a traditional Open Doors day. Still, we didn't want to deprive the prospective students of the possibility to look into the laboratories and, first and foremost, to get answers for actual responses to their questions related to study and individual study programmes.


Photo: Jana Valchová

Finally, we managed to make an online meeting, which was started by a short live broadcast introducing the faculty, study programmes and student life at the faculty. It was followed by discussion groups with a representative of individual bachelor programmes in the MS Teams, which were complemented by prepared videos from the laboratories and faculty premises.

### 27.

### St. Nicholas' meeting of the Young Generation of the Czech Nuclear Society

St. Nicholas' meeting is an event organized by the Young Generation of the Czech Nuclear Society and co-organized by the Department of Electrical Power Engineering intended for young people working or studying in a nuclear field. The aim is to connect people from different parts of the Czech Republic and to give them opportunity to present their work.

## FEBRUARY

### 3.

### A new faculty video was released for study applicants

Photo: Jana Valchová

After a couple of years, a new promotional video was created to attract students to study at the FEEC, saying: "Here you can't go wrong!"

### 12.

### Online Open Doors Day for prospective students

Photo: Jana Valchová

Last day of open doors day attracting applicants to 2021–22 academic year had the same format as the previous one, i.e. online broadcasting combined with discussion groups on the MS Teams.

## MARCH

### 25.

### AT&T TechCon 2021

An online conference for secondary school students interested in ICT was held. It was the fourth year of the conference organized by the FEEC (UTKO) and it was focused on cryptography, web applications, artificial intelligence and 3D print.

### 26.

### EBEC 2021 technical contest local round

Photo: BEST Brno archive

The BUT hosted EBEC (European BEST Engineering Competition), the biggest international technical competition, for university students. The competition is intended for four-member teams which compete either in Team Designs, where they create a functional device, or in Case Study, where they create a theoretical solution design. In both categories, the winning teams were from the FEEC.

## APRIL

### 19.–21.

### The Microwave and Radio Electronics Week 2021 – MAREW 2021

MAREW is hosted by the UREL, in cooperation with Czech and Slovak technical universities. The aim of the conference is to make a discussion forum for scientists, academic workers, professionals from industry and students who are interested in latest developments in electronics, signal processing, information technologies, microwave techniques and related field.

### 20.

### Ceremonial opening of the 5G network laboratory #VodafoneUniLab

Photo: Jan Prokopius

A new laboratory Vodafone Unilab on the UTKO premises was ceremoniously opened in presence of the FEEC and Vodafone representatives. The main aim of the laboratory is to connect

academic sector with industrial partners and it offers space for testing and development of IoT or Industry 4.0 devices.

27.

## 27th Student EEICT 2021 conference and contest and 12th Job Fair

It was the second time the contest and the job fair had to be held online due to the risk of coronavirus spread. 4 bachelor, 7 master, 11 doctoral and 1 secondary school categories competed online in MS Teams, there were altogether 188 contest contributions.

Photo: Jana Valchová

The contest was broadcasted online and the Dean of the faculty had an opening speech. Jaroslav Koton, the vice-dean for creative activities, reported the broadcasting and he announced winner prizes at an overall amount of almost 500,000 CZK. Since 2020, winning contributions are also indexed in the Web of Science database. The finals recording was watched online by 1,280 spectators on Facebook and YouTube. At the same time, perFEKT JobFair 2021, a fair of job opportunities, was held. Students could watch online presentations of partner companies on the website and during ceremonial announcement of contest winners.

MAY

27.

## Microcontrollers are in! Contest 2021

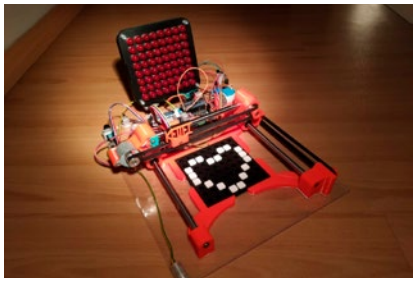


Photo: UETE archive

The Department of Theoretical and Experimental Electrical engineering organizes every year a popular contest for creative secondary school and university students, be it individuals or teams, who like playing with MCU. Competitors' task is to design and create a functional device containing a microcontroller. During the contest they can use the equipment of the selected laboratories. The contest finishes with the device presentation and show in front of a committee from professionals from industry and BUT. The contest in 2021 was held only online.

JUNE

17.–18.

## International conference MITAV 2021 (Mathematics and information technology and applied sciences)– MITAV 2021

The conference is primarily intended for teachers of all types and grades of school and it focuses on the latest findings in mathematics, informatics and other sciences. The conference is co-organized by the Department of Mathematics.

23.–25.

## 42nd NZEE conference on non-conventional sources of electric power

42nd conference, as the previous one, was influenced by the current state of things related to COVID-19 pandemic. Due to the Covid situation the conference was postponed from May to the second half of June.

Photo: UETE archive

The conference is held by the Department of Electrical and Electronic Technology and it deals both with the most common renewable resources such as photovoltaics, wind and solar energy, as well as with the less common ones like geothermal energy or biomass energy, etc.

28.

## PicoBalloon Challenge 2021

Photo: UREL archive

Doctoral students from the Department of Radio Electronics, Jan Král and Martin Pospíšil, took part in PicoBalloon Challenge 2021 contest, organized by the Brno Observatory and Planetarium. Competitors' task was to make a device capable of transmitting basic information on its location (the required minimum is an identification and an approximate height). The winner must prove that, based on the data, its transmitter hovered the longest time in the air. Starting weight of their probe was only 10.5 g. The probe was a PCB of 36 x 17 mm size only and it carried radio amateurish communication systems APRS (144.8 MHz in Europe) and WSPR (14.097 MHz). The probe signal was audible from the Black Sea to the USA, i.e. about more than 8,000 km.

# JULY

14.

## Summer city camp at the FEEC

Photo: Jana Valchová

The first round of summer city camp visited our university interactive playground called Elektrikárium. Children enjoyed a funny morning there, and had a lot of fun with 15 educational exemplars including a laser harp or RC car models.

26.–28.

## 44th International Conference on Telecommunications and Signal Processing (TSP)

44th International Conference on Telecommunications and Signal Processing is held by the Department of Telecommunications in cooperation with IEEE Region 8.

## AUGUST

**11.**

### Electro camp at the FEEC

About sixty fans from the age of ten to sixteen visited the electro camp at the faculty. They were accompanied by the Department of Radio Electronics staff who showed them other departments as well.


Photo: Elektro tábor archive

Children were introduced to our laboratories of optical communication, electromagnetic compatibility, antenna and satellite technique, including ground station.

**11., 18.**

### Summer city camp at the FEEC

Photo: Jana Valchová

Two more rounds of a summer city camp visited an interactive playground Elektrikárium during August. The activities had a similar character to the first round in July.

**22.–25.**

### 22nd Advanced Batteries, Accumulators and Fuel Cells (ABAF) International Conference

The Department of Electrical and Electronic Technology organized an attended conference following all the epidemic rules. The conference deals with modern batteries and electrochemical technologies.

**26.–31.**

### BUT Initiating event

Two initiating events were held as an getting-to-know-you activity of first year students who enrolled in September at the FEEC. This official four-day event was organized by students together with students' clubs such as BEST Brno, Students for Students, IAESTE or ESN BUT. This year it was the 11th round.

Photo: Jakub Rozboud

This year it was an exception to have two terms, but because of the distance learning, participation was allowed to second year students as well.

## SEPTEMBER

**2.**

### Prof. Radulescu Lecture

The Department of Control and Instrumentation organized a lecture by professor V. Radulescu from the Romanian university in Craiov, who is the founder and chief editor of 'Advances in Nonlinear Analysis' journal. The journal belongs to the five best mathematician journals in the world (according to the WoS). In the lecture prof. Radulescu explained the history and significance of some of his results from nonlinear elliptical equations.

**3.–10.**

### Summer school of nuclear engineering

Photo: Summer school of nuclear engineering archive

Summer school for people interested in future development of nuclear power was co-organized by the Department of Electrical Power Engineering in cooperation with ČVUT FEL. Participants were presented thematic lectured given by big names in Czech nuclear energy: Mrs. Drábová, Mr. Zronek, Mr. Zdebora, Mr. Kawalec and others.

**4.**

### BlueEMI Amper Open

Photo: UREL archive

This year, UREL organized a tennis doubles match BlueEMI Amper Open for the second time. The tournament was again held at the CESA courts and this year 8 pairs participated. After a demanding match, Tomáš Frýza and Petr Kadlec managed to win. The match was supported by BlueEMI company.

**6.**

### Opening of a unique quantum security laboratory

A laboratory of quantum security was ceremoniously opened at the Department of Telecommunications premises in presence of the representatives of the FEEC, MU, NÚKIB and MVČR. The laboratory will enable scientists to work at computer networks of a new generation which will be protected


Photo: Jan Prokopius

against quantum computers as well, which most current networks are vulnerable to, including the internet.

**11.**

### Ceremonial graduation of master studies

Photo: Jakub Rozboud

Graduations in 2021 were a bit different from the usual ones. They were unusually in autumn and only for master studies.

**12.–15.**

### 48th Computing in Cardiology 2021 International Conference

The Department of Biomedical Engineering hosted an international conference Computing in Cardiology,

which unites scientists and specialists from medicine, physics, engineering and computer sciences. Conference participants focused on usage of computational technology for clinical cardiology and cardiovascular physiology.

Photo: Oto Jarošek

This year's conference topic was artificial intelligence.

16.–17.

## Open days at laboratories

Photo: Jakub Rozboud

Even before the semester start, selected departments realized an open day at laboratories. Students could try out selected tasks which, due to online teaching in the previous academic year, they could see only indirectly.

17.–19.

## PerFEKT start

Photo: Jakub Rozboud

Traditional welcoming event for first year students of bachelor study programmes was organized by students from the Students for Students Club (SPS). Incoming students had an opportunity to see the faculty premises and their prospective classmates. They got practical tips for subjects registration and for the study at the FEEC in general.

17.–20.

## Workshop ARES ETACS 2021

An international workshop organized by the Department of Telecommunications was aimed at trends in education and on cybersecurity. The workshop was visited by representatives from foreign universities (e.g. Italy, France, Austria or Latvia) and key institutions, especially ENISA (The European Union Agency for Cybersecurity) and NIST (National Institute of Standards and Technology). Workshop results formed part of the official conference paper collection.

22.

## Music from the FEEC

Photo: Samuel Gubi

13th Music from the FEEC, a traditional student festival, was held and after a year break it attracted a record number of students who came to say goodbye to summer by music.

Photo: Samuel Gubi

The festival, which is also a student music bands contest, was won by The Arcane Legacy band.
In the evening, the main headliner, a well-known Slovak music band Horkýže Slíže, closed the festival.

24.

## Scientists' night

Scientists' night in Brno offered online lectures, podcast and experiments in attended form.

Photo: Jan Prokopius

Visitors could visit faculty premises where a popular science programme was prepared on the topic of Time in all its forms.

Photo: Jan Prokopius

A traditional Tesla transformer offering an unusual electrising show could not be missing.

# OCTOBER

4.

## Support centre opening 'M.A.S.H. – Mathematical emergency'

Department of Mathematics centre employs tutors who offer help especially to first year students enrolled to 'Mathematical seminar' and 'Mathematics 1'. The project supported by the Norwegian funds helps students to overcome initial problems with university mathematics.

7., 14. a 21.

## Series of lectures on More electric aircraft


Photo: Vladimír Pokorný

Ten lecturers from BUT academics and experts from practical life, who presented altogether 18 interesting topics related to the future of aircraft. This could be a summary of a series of lectures on the development and future of the aircraft technologies which was organized by the Department of Theoretical and Experimental Electrical Engineering together with the Institute of Aerospace Engineering and Institute of Solid Mechanics, Mechatronics and Biomechanics of the BUT in cooperation with Honeywell s.r.o. and ATAS elektromotory Náchod a.s.


Photo: Vladimír Pokorný

Lectures were intended for wide professional as well as amateur audience with interest in aerospace technology. The lectures were broadcasted online and they had almost 420 views and right in the lecture hall there were about 50 students.

21.–22.

## IMAPS Flash Conference 2021

Photo: UMEL archive

The Department of Microelectronics in cooperation with IMAPS professional

company organized 7th IMAPS Flash conference 2021 focused on microelectronics, soldering technology, encasing, nanotechnology and other.

25.–27.

## ICUMT 2021

13th International congress on ultramodern telecommunication and control systems. Due to the pandemic of COVID-19, this year was online. The congress is organized by the BUT, Tampere University, University RUDN and several industrial partners.

## NOVEMBER

12.

## Platform for Research and Development in Cybersecurity

Photo: Jakub Rozboud

The second round of Platform for Research and Development of Cyber and Information security was held in the premises of the Department of Telecommunications. The activity of the platform is secured by the National Cyber and Information Security Agency.

16.

## Merkur perFEECt Challenge 2021–2022

Photo: Jakub Rozboud

The first round of Merkur perFEECt Challenge 2021–22 was joined by 47 teams from 24 schools. As every year, teams were divided into 9 groups according to the given task, such as making a functional model of a wind power plant with an accumulator, or a vehicle controlled by a light belt.

20.–21.

## BASTLfest in the VIDA centre

Photo: UREL archive

OK2KOJ radio club and the Department of Radio Electronics workshop held during BASTLfest in the VIDA! centre was visited at the weekend by more than 100 enthusiastic prospective kludges. During the workshop, in Labodílna, there were many things available, such as traditional police beacon or siren construction kits, electronic dice, simple lights and flicking stars. Visitors could take home their constructed and relived devices as a memory. Electronics is all around us and we are happy that we could demonstrate it not only to children, but also to their parents.

23.–26.

## Gaudeamus Brno 2021

Photo: Jan Prokopius

At the post-A-level education fair Gaudeamus Brno BUT and FEEC could not be missing.

26.

## ETS6 Days

Photo: UEEN archive

In November the Department of Electrical Power Engineering held an event called 'ETS6 Days' focused on KNX intelligent electrical installations. More than 120 professionals from industry and technical universities participated there. The event was held concurrently in other 20 European countries.

# DECEMBER

7.

## Dean's election

Academic senate of the faculty elected a new dean for the period of February 2022 until the end of January 2026. They elected the current dean of the faculty, Vladimír Aubrecht, who will continue from his current four-year period into a new one.

9.

## Online Open Doors Day for prospective students

Photo: FEKT archive

The online open doors day had a new format this year where prospective students could ask our representatives questions in a talk show. Prepared reports on individual study programmes with real students were also a part of the show, as well as general presentation on possibilities of study presented by the Vice-dean for International and Public relation. The show was accompanied by a student presenter.

12.

## Python and machine learning

In December, the Department of Radio Electronics organized a four-part practical course where participants got introduced to basics of Python language and to PyTorch libraries and TensorFlow for effective machine learning implementation. Every part of the course was attended by about 40 participants: some of them in present and others online.

# INTERNATIONAL RELATIONS AND FEEC

Despite the unfavourable pandemic situation which has been strongly limiting students and staff mobility for two years, we managed to realize several student internships and education stays abroad. Usually, these were neighbouring countries with the Czech Republic. Nevertheless, the mobility number did not reach the level before COVID-19. Furthermore, an international summer school for foreign students had to be postponed again, namely Brno International Summer School on Electronics and Communication Technologies – BISSECT.

As far as the internationalization is concerned, the faculty was very active in preparation of common consortium of European universities called EULIST, including the preparation of a project to be financed by the Erasmus+ under 'European universities' call. The faculty managed to get an accreditation for another master study programme in English focusing on Space Applications. This programme will probably be accredited as another double degree study programme, which will be united with Georgia Tech from the USA. The negotiations are still in progress and we suppose that they will be successfully finished in 2022. Furthermore, negotiations on a new double degree doctoral study programme with the Northern Illinois University are being finalized. The faculty cooperates with this university in master study programme of Microelectronics.

Photo: UBMI archive

## Cooperation with UAS Technikum Wien

Teachers from the Sporting Technology study programme, taught in cooperation with the FEEC and CESA, started an international cooperation with UAS Technikum Wien. Viennese students spent two weeks in Brno during which they realized their yearly projects and measured technical aspects of technologies they had designed for commercial companies. At the end of the event students and their professional lectors gave their know-how to Brno teachers.

## FEEC BUT becomes a scientific partner for an Austrian research Centre K2 – Linz Center of Mechatronics and Johannes Kepler Universität in Linz

The Austrian Research Centre started a very ambitious research programme at an excellent level which aims at establishing the foundations of mechatronics transformation for the future, together with the best researchers, scientific and company partners from all over the world.

Centre K2 has 46 corporate and 51 research partners among which from 1 January 2022 you can find the Faculty of Electrical Engineering and Communication at the BUT. University workplaces from all over the world together with the BUT will participate at the research there.

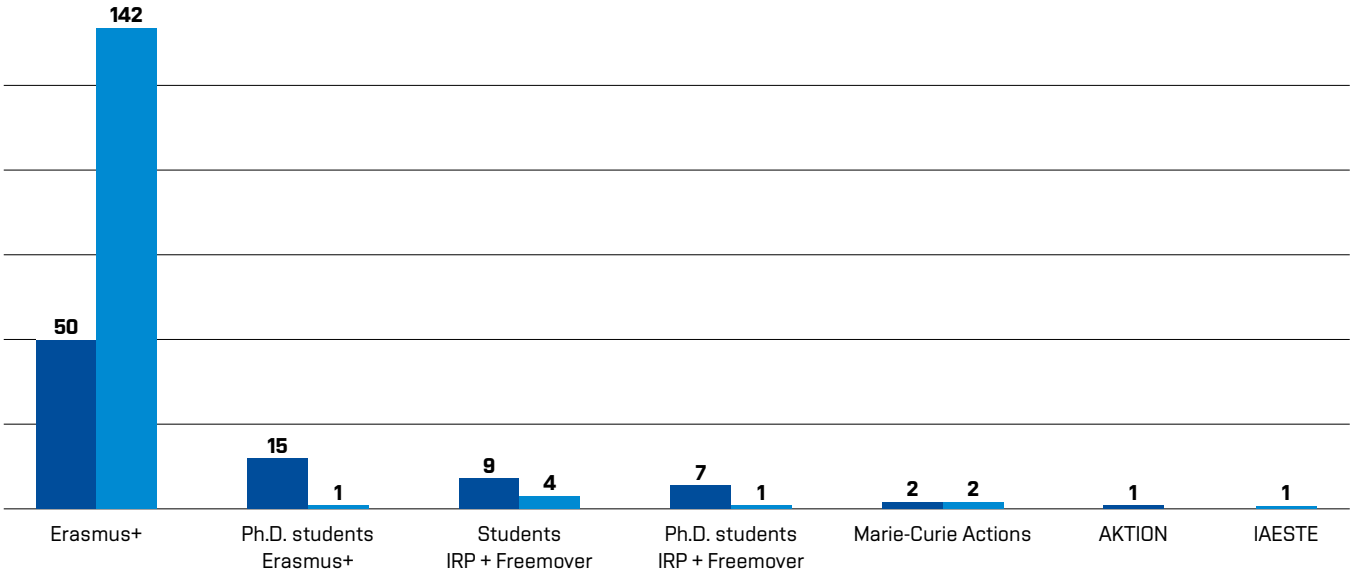
In order to strengthen the cooperation with the Johannes Kepler University in Linz and Linz Center of Mechatronics, our workplace hosted a visit in October 2021 which was attended by the employees from the Department of Theoretical and Experimental Electrical Engineering as well as four selected master students.

Students were actively participating at the visit programme by presenting their bachelor theses and they found their diploma theses supervisors from the BUT and JKU in Linz right on the spot.

Photo: UVEE archive

# Number of FEEC students on research stays in 2021

## Incoming and outgoing students by programmes

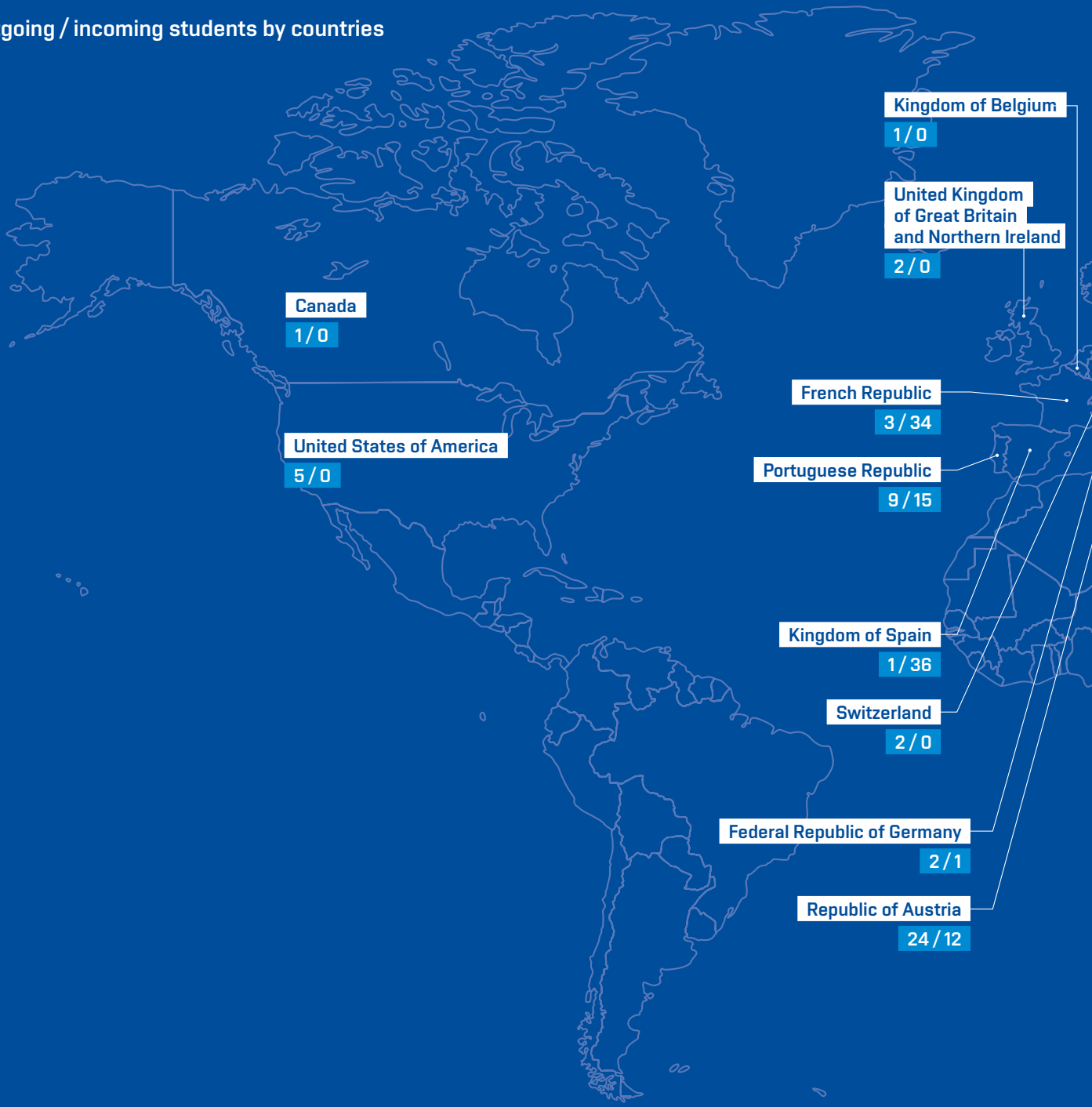



| | |
|---|---|
| Number of outgoing students: | 84 |
| Number of incoming students: | 151 |
| Number of outgoing academic staff and researchers: | 40 |
| Number of incoming academic staff and researchers: | 14 |

Number of outgoing students

Number of incoming students

## Outgoing / incoming students by countries




Kingdom of Norway
1 / 0
Republic of Finland
11 / 0
Kingdom of Sweden
2 / 0
Republic of Estonia
5 / 2
Republic of Lithuania
1 / 4
Kingdom of Denmark
2 / 0
Republic of Poland
0 / 1
Russian Federation
1 / 0
Republic of Slovakia
0 / 3
Islamic Republic of Iran
0 / 1
Republic of Korea
5 / 0
Romania
0 / 4
Israel
1 / 0
Republic of India
0 / 1
Taiwan
0 / 1
Republic of Turkey
0 / 19
Hungary
1 / 0
Hellenic Republic
0 / 13
Republic of Slovenia
1 / 0
Italian republic
3 / 4

# INDUSTRIAL PARTNERS















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The faculty is an important partner for many international as well as Czech companies in joint research and pedagogical projects.

## How to cooperate with us

- Projects of applied research
- Research projects
- Cooperation in teaching, supervision of diploma theses
- Joint preparation of grants
- Contracts
- Support of faculty events
- Partner promotion in faculty premises

If you are interested in cooperation with us, see our webpage or contact Vice-Dean for International and Public relations.

**Vice-Dean for International and Public relations**
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FACULTY OF ELECTRICAL ENGINEERING AND COMMUNICATION

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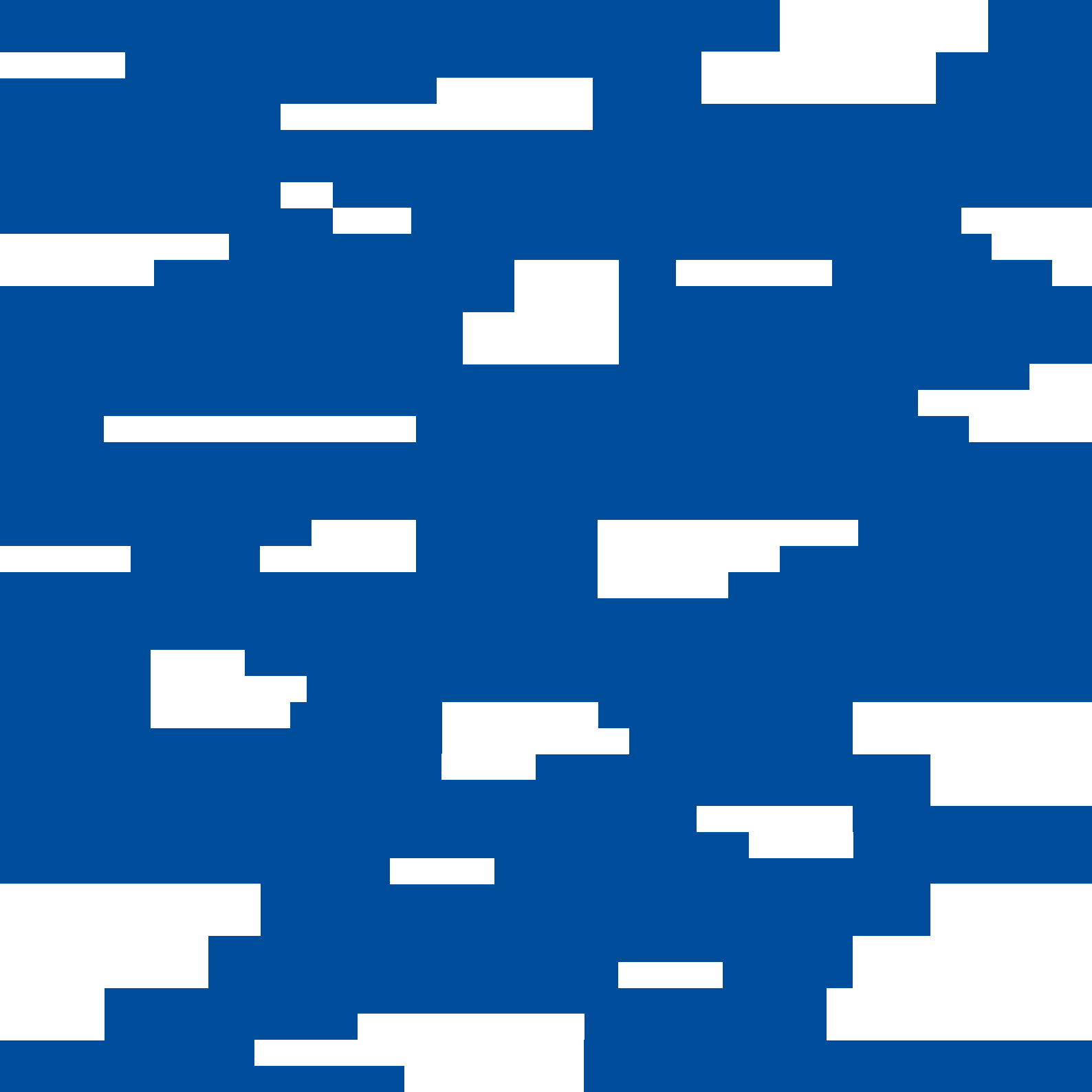

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