

Open Day for Applicants for Doctoral Studies at CTU FEE



Prague
March 23, 2023



Programme

1. Introduction - Petr Páta, Dean of FEE
2. Scientific Activities and Doctoral Study at CTU FEE - M. Polívka, Vice-Dean for DS&S
3. [PhD Success Stories](#)
4. Discussion with participation of supervisors, chairs of scientific boards, heads of departments and graduates, ..





Scientific Activities at CTU FEE

FEE Mission & CTU Ranking

Mission – to provide **education** and **conduct world-class research** in the fields of **electrical engineering** (EE) and **computer science** (CS) with overlap into the **natural, medical, economic** and **human sciences**:

air and space, biomedical, and power engineering; acoustics, applied physics, automation control; cybernetics; computer science; graphics; history of science, management and energy economics; mathematics; material science, microelectronics; radioengineering; robotics; telecommunication, ..



CTU, 2023: #378 (2022: #403, 2021: #432, 2020: #498, 2019: #531-540)
FEE, 2022: EE #201-250, CS #151-200

Government evaluation of research organization 2020, methodology M17+,
with international evaluation panel

FEE evaluated „Excellent“
in Eng. & Techn.
252/267 points,
1st of 13 parts CTU.



A Brief Look at Science at FEE

Strength

- Established scientific teams, <https://intranet.fel.cvut.cz/en/research/teams/>
- High-quality publication standards (IF journals, conferences CORE A*, A)
- High-end laboratory equipment (HW, SW)
- International collaborations (projects, common teams, internships)
- Prizes & awards (individual, team)
- Results commercialized (licences sold, start-ups)

Results

Result type / year	2022	2021	2020	2019	2018	2017
WoS IF journal papers ¹⁾	345	350	344	323	317	305
WoS citations ^{1,2)}	10 588	11 390	9 502	10 392	8 790	7 917
Patents US+Jap+EU / totally	5 / 18	1 / 12	9 / 15	12 / 20	6 / 10	4 / 12

¹⁾ According to V3S, February 2023, ²⁾ heterocitations

~ **1/3** scientific results of the CTU, 2022 (V3S)

Publikace Jimp: 30 % absolutely, **34 %** considering author's shares

Citace: 41 % absolutely, **43 %** considering author's shares



Selection of the best R&D results and achievements

5 examples demonstrating:

- support from domestic/foreign **grant agencies** or **foundations**,
- Involvement in **international collaborations**/transnational projects,
 - **presentation** and **publication** of **results**, social impact,
 - **patent** protection and **commercialisation** of results,
 - **awards** received.

28 more in the Appendix

MBZIRC 2020 competition in Abu Dhabi <http://mrs.felk.cvut.cz/mbzirc2020>

Multi-robot Systems group, Dr. Martin Saska, Dept. of Cybernetics

2nd challenge: 1st place US\$ 250.000, 1st challenge: 2nd place, TOTAL: 1st place



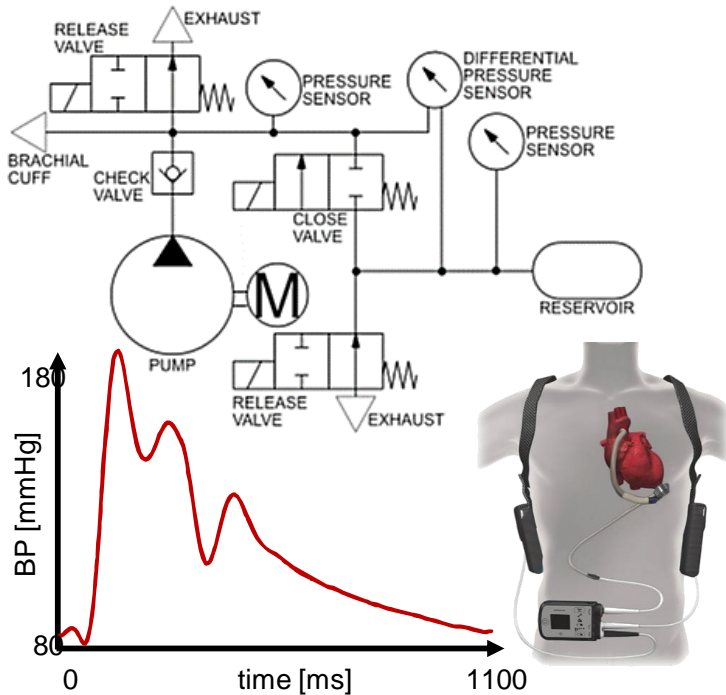
Congratulations

- 1. challenge: to capture and neutralize intruder UAVs
- 2. challenge: to autonomously locate, pick, transport and assemble different types of brick shaped objects to build pre-defined structures
- 3. challenge: to autonomously extinguish a series of simulated fires in an urban high rise building



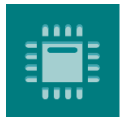
Method for accurate automated non-invasive measurement of blood pressure waveform

Dept. of Physics, Vratislav Fabián



Validated against the gold standard of PWV measurement.

<https://v3s.cvut.cz/results/detail/332373>



sensors

- **Very sensitive, non-invasive** assessment of hemodynamic parameters of human cardiovascular system (Pulse Wave Velocity - PWV etc.)
- **Unique technology** for measuring blood pressure in **LVAD** (Left Ventricular Assist Device)
- The work is **based on our US Patent US10251567** “Method for an accurate automated non-invasive measurement of blood pressure waveform” (2019)
- Research cooperation with Human Integrative and Environmental Physiology Laboratory **MAYO Clinic**, Rochester, USA
- Support from Technology Agency of the Czech Rep. Grant No. TH04010173 **Apparatus for non-invasive automatic analysis of hemodynamic parameters**
- The work has been **cited in respected journals**: Nano Energy, Heart Failure Reviews



<https://v3s.cvut.cz/results/detail/323874>

<https://v3s.cvut.cz/results/detail/331312>

SIMToolbox – Live cell microscopy beyond the diffraction limit

Dept. of Radioelectronics, MMTG, Miloš Klíma

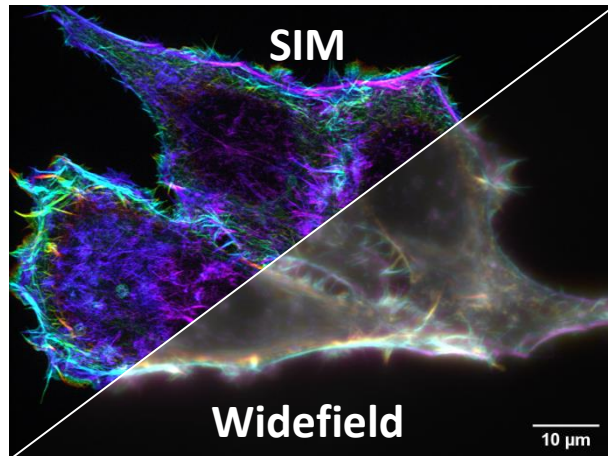
Karel Fliegel, Tomáš Lukeš, Jakub Pospíšil

MATLAB open-source project for fluorescence structured illumination microscopy (SIM)

Twofold increase in resolution – breaking the diffraction barrier

Currently more than **400 users**

Developed and supported by CTU (simtoolbox.github.io)



International collaboration:

[EPFL, Switzerland](#)

[UCCS, Colorado, USA](#)

[UNI Bielefeld, Germany](#)

Associated publications:

[Opt. Express 2014 \(Q1\)](#)

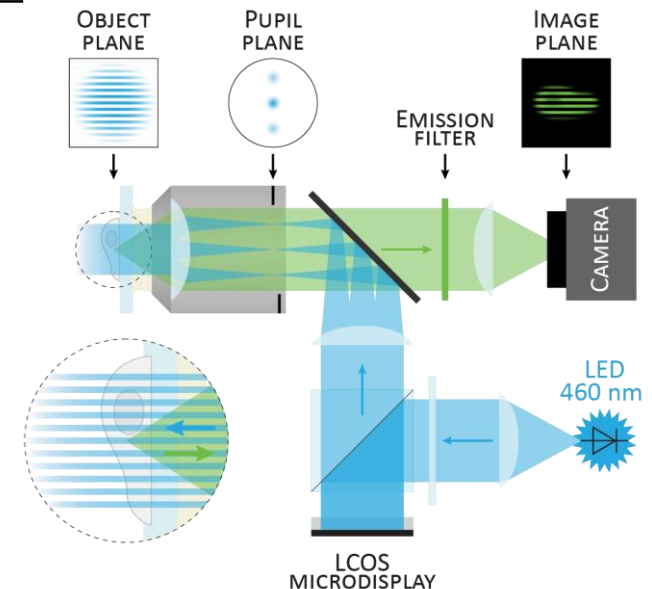
[Bioinformatics 2016 \(Q1\)](#)

[GigaScience 2019 \(Q1\)](#)

Received grants/projects:

Jakub Pospíšil (2018-2021, ESR) – [project DeLIVER](#)

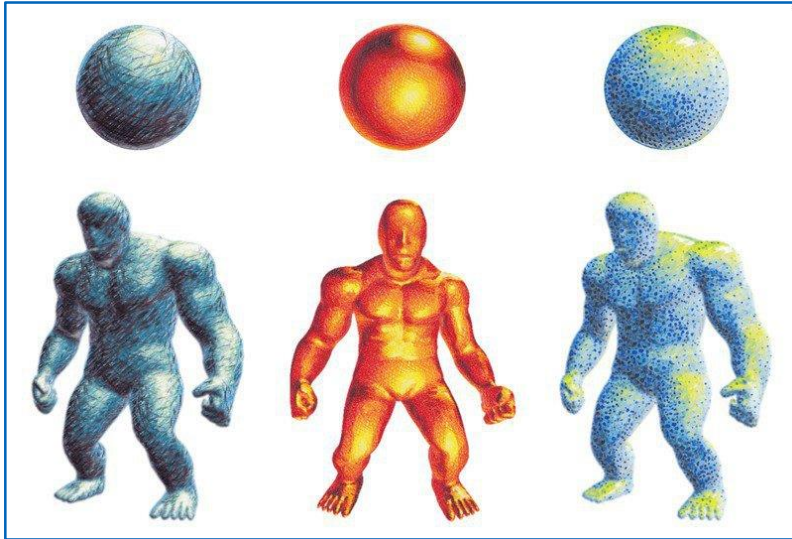
H2020 Innovative Training Network, No. 766181



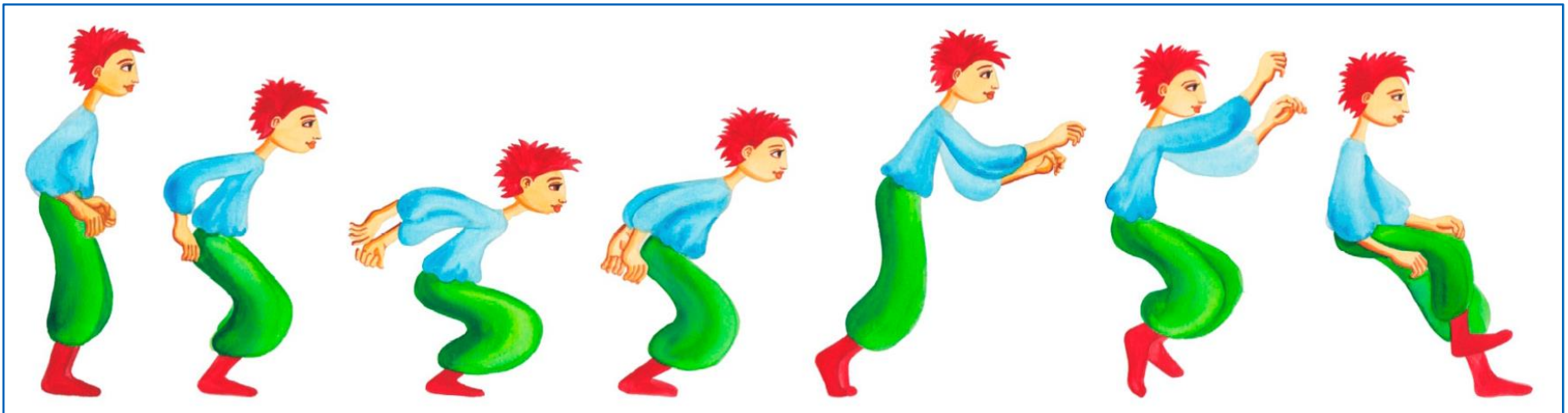
SIM setup built and operated at UCCS

Example-based Stylization of Images and Videos

Dept. of Computer Graphics & Interaction (DCGI), prof. Daniel Šýkora's group



- 8 SIGGRAPH papers
- 6 US patents
- 4 free Software Tools ([EbSynth](#), [StyleBLIT](#), [FaceStyle](#), [StyLit](#))
- 2 companies have included results (Adobe, Snap)





Doctoral Studies at CTU FEE



I'M A PHD STUDENT



WHAT MY FRIENDS THINK I DO



WHAT MY MOTHER THINKS I DO



WHAT SOCIETY THINKS I DO



WHAT MY ADVISOR THINKS I DO



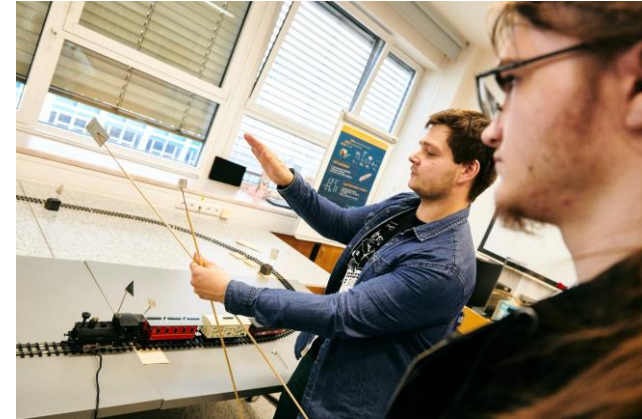
WHAT I THINK I DO



WHAT I ACTUALLY DO

Essential Information

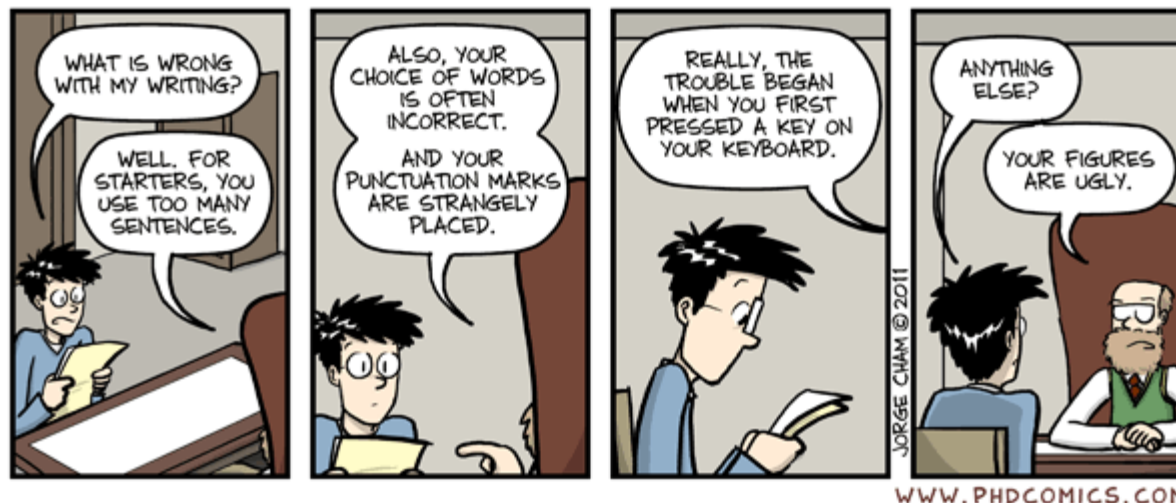
- **Ph.D.** - “Doctor of Philosophy”, the highest level of higher education „*philosophiae*” – from Latin, Greek „love of wisdom“
- **Content:** scientific research on a "dissertable" topic under the supervision of a supervisor
(*having the potential of finding original results surpassing the current state of knowledge; to make a **contribution to the state of the art***)
- **Forms:** full-time/combined
- **Standard length:** 3-4 years
- **Evaluation and study checks :** [Doctoral Study Code & dean’s directives](#),
- **Prerequisite for admission:** completed university education, knowledge of EN language
- **Commencement of studies:** February 1/ September 1
- **Applications before:** April 30 / October 31



<https://intranet.fel.cvut.cz/en/education/phd/study>

Standard Timeline I.

- Selection of the **framework topic** <https://fel.cvut.cz/cz/education/phd/phdtopics>
- **Agreement** with a potential **supervisor**
- **Application** submission, admission procedure
- **Scientific work** under the guidance of a **supervisor** according to **Individual Study Plan**
 - presentation of results at international conferences, scientific journals
 - short-term internships ([financial support](#)), summer schools, scientific consortia meetings, ..
- **Study stage:** 2/3 years, min. **2** **profess. courses** (Scientific Writing, ..), **1** **scientific artical**



Standard Timeline II.

- Optional **pedagogical practice**
- Defence of a **progress study** („minimum“) - preparation for a dissertation; **EN** exam
- **State Doctoral Exam** (given by law), **seamless merging** of **SDE** and „minimum“
- Compulsory **foreign experience** (internship, min. 1 month, preferably 6 months, ERASMUS+)
- **Thesis defence: 3** scientific articles, min. **1 IF** journal paper / conf. paper **CORE A***, **A** / **MathSciNet**
- [Dean's Award](#) for an excellent dissertation 😊



Doctoral Study Programmes

- Acustics (together with FSv, FS)
- Aerospace and Space Technology
- Applied Physics
- Bioengeneering
- Cybernetics and Robotics
- Electrotechnics a Communication (4 spec.)
- Economics of Energy and Electrical Engineering
- History of Science and Engineering
- Informatics (3 spec.)
- Matematical Engineering



Doctoral students & supervisors (2022)

Totally: **360** (~ 10 % of all FEE students)

Graduates: **26**

Accepted (from FEE, outside of FEL\of which foreign): **64** (26, 38\20)

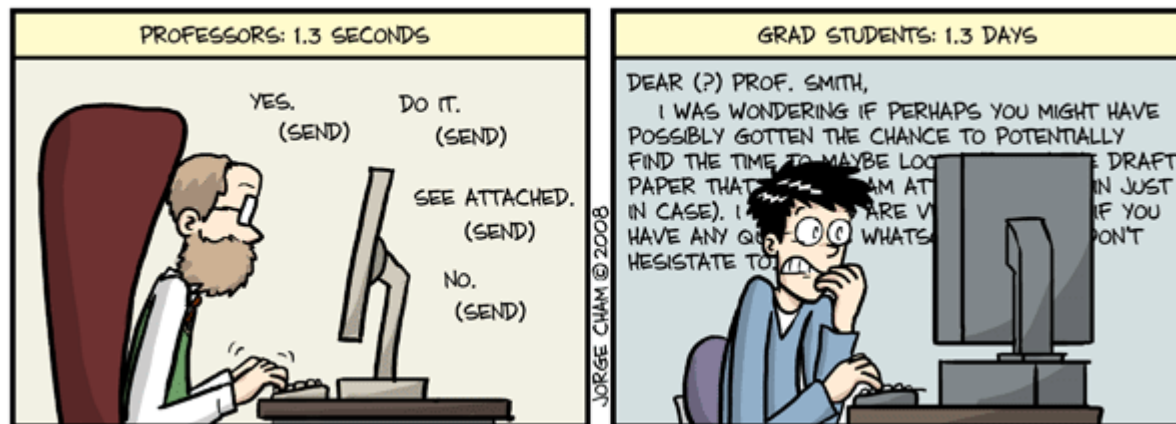
Supervisors (prof., assoc. prof. + approved by Scientific Council FEE): **217**

~ 1.7 doctoral students/supervisor

Tips & Hints for the Beginning of Your PhD Study

- **Read** (scientific) **papers**: 30-40 per 1st year
- **Consult** regularly with your **supervisor** (and also with your PhD classmates)
- Be **curious** and **critical** (of what your supervisor tells you),
- Set up proper **time management** (especially for writing articles/papers, reviews!),
- Improve your **scientific writing skills** & English

AVERAGE TIME SPENT COMPOSING ONE E-MAIL



WWW.PHDCOMICS.COM

Last but not Least: Money

- **Scholarship + (Project) Income: net income 35-52 thousand CZK/month** (20th - 80th percentile), corresponds to a **gross income of 44 - 67 thousand CZK/month**
- You can **concentrate on your work** and **stay** in the lab as long as you want 😊



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PhD Success Stories

PhD Success Stories

<https://fel.cvut.cz/cz/vv/doktorandi/success-stories/>

PhD Success Stories / Medailonky úspěšných absolventů

1. Where do you currently work and what is the scope of your work?
2. What has your doctoral studies given you for your current career?
3. Where have you been during your doctoral studies and where have you been at postdoc?



Mgr. Hynek Bakštejn, Ph.D.

Patent examiner, [European Patent Office \(EPO\)](#), Munich, Germany

Supervisor: prof. Ing. Václav Hlaváč, CSc.
Supervisor-specialist: Ing. Tomáš Pajdla, Ph.D.

[Intro & Answers](#)



Ing. Ondřej Bruna, Ph.D.

Software Engineer, [Kassow Robots ApS](#)

Supervisor: Prof. Ing. Jan Holub, Ph.D.

[Intro & Answers](#)

Questions:

1. Where do you currently work and what is the scope of your work?

Industry: senior R&D engineer, chief scientist, head of reserach lab, patent examiner (EPO), CEO in world-wide international companies.

Academia: postdoc, researcher, vice-dean - international universities, Academy of Science CR.

2. What have your doctoral studies given you for your current career?

Analytical & critical thinking, detailed analysis of problems, and ability to find the state of the art for a given problem and assess its relevance, .., meet the best scientists and researchers in the field, hard-working people who aim to push the boundaries of the state-of-the-art as much as you do, opportunity to travel the world, gain knowledge and experience that would be otherwise very hard or even impossible to get.

3. Where have you been during your doctoral studies and where have you been at postdoc?

Several months spent at international universities (incl. EPFL, MIT, ..) and/or world-wide companies.

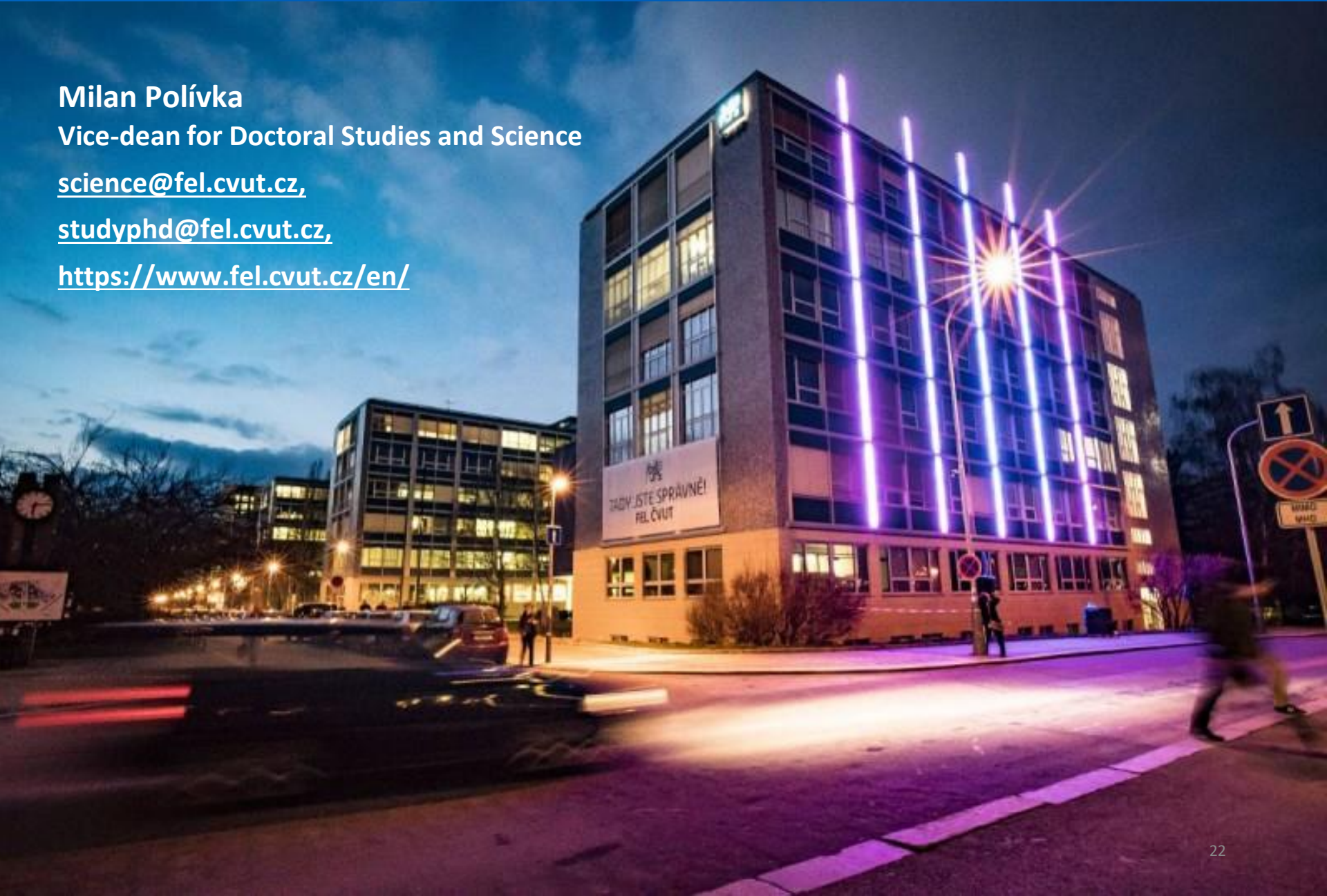
Milan Polívka

Vice-dean for Doctoral Studies and Science

science@fel.cvut.cz,

studyphd@fel.cvut.cz,

<https://www.fel.cvut.cz/en/>





Selection of the best R&D results and achievements

Appendix

From Ground to Space

Dept. of Radioelectronics, O. Nentvich¹, M. Urban², R. Hudec

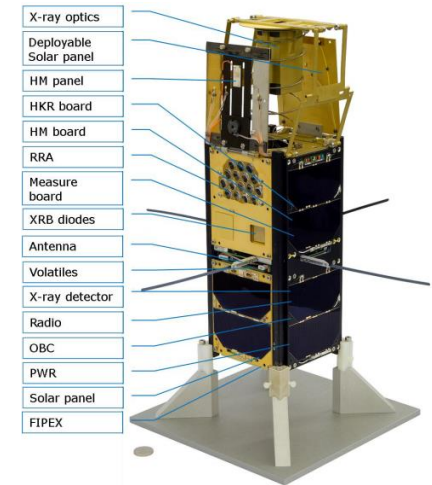
Nanosatellite VZLUSAT-1

- **Three years of successful operation** in Low Earth Orbit (since **June 23, 2017**)
- Verification of **newly developed materials and technologies** in/for space
 - **Carbon-fibre reinforced plastics testing**
 - **X-ray Lobster-eye optics** and Timepix detector
 - Photovoltaic panels
 - Ground station in Pilsen
- **Collaboration** of two universities (UWB and CTU) and several companies (VZLU, RITE, ADVACAM, ...)

Rocket experiment (REX)

- Two payloads (CZ - REX and US - WRXR) as a part of NASA's sounding rocket launched on April 4, 2018
- Two **X-ray Lobster-eye optics** with **Timepix detectors**, visible camera, MEMS and IR sensors driven by the autonomous Robot Operating System
- **International collaboration:** Penn State Uni. (US), UWB (CZ) universities; other parts of CTU (Cyber. & Physics. Dept., IEAP); research center PANTER MPE (DE), VZLU (CZ); companies RITE, ADVACAM (CZ)

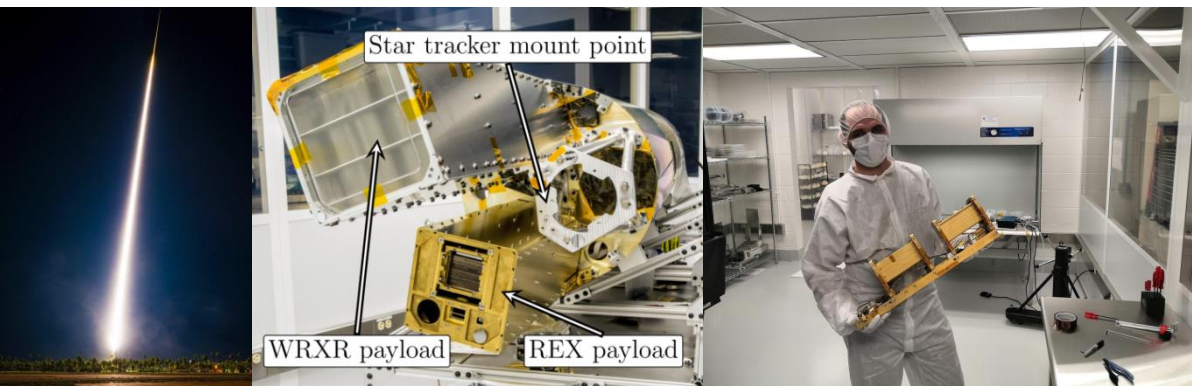
¹ondrej.nentvich@fel.cvut.cz , ²martin-urban@fel.cvut.cz



Left: REX launch

Middle: Two payloads placed on the sounding rocket during the embedding phase

Right: Testing after rocket sea recovery and after launch testing at Penn State University, US



URBAN, M., NENTVICH O., et al., 2017. VZLUSAT-1: Nanosatellite with miniature lobster eye X-ray telescope and qualification of the radiation shielding composite for space application. *Acta Astronautica*. (Q1, JIF Percentile = 88.710)

DANIEL, V., et al., 2019. In-Orbit Commissioning of Czech Nanosatellite VZLUSAT-1 for the QB50 Mission with a Demonstrator of a Miniaturised Lobster-Eye X-Ray Telescope and Radiation Shielding Composite Materials. *Space Science Reviews*. (Q1, JIF Percentile = 88.971)

Visual Recognition Group, prof. Jiří Matas, Dept. of Cybernetics

publishes at the most prestigious journals and conferences. The most impacted publications include:

Iscen, Tolias, Avrithis, Chum: *Label propagation for deep semi-supervised learning*, CVPR 2019

100 citations in Google Scholar (in 1 year), CVPR is the fifth best publication source according to [Google Metrics](#)

Radenović, Tolias, Chum: *Fine-tuning CNN image retrieval with no human annotation*, TPAMI 2018

IF 17.861, 254 citations, extension of ECCV 2016 paper – 429 citations

Kupyn, et al.: *Deblurgan: Blind motion deblurring using conditional adversarial networks*, CVPR 2018

447 citations

Lukezic, et al.: *Discriminative correlation filter with channel and spatial reliability*, CVPR 2017

595 citations

Mishchuk, et al.: *Working hard to know your neighbor's margins: Local descriptor learning loss*, NIPS 2017

190 citations

Prizes awarded to the group members:

Honorable Mention for Outstanding Contribution Award at GCPR 2019

Saburo Tsuji Best Paper Award at ACCV 2018

Longuet-Higgins Prize at CVPR 2017

Best Science Paper Honorable Mention at BMVC 2017

Winner of ICDAR Robust Reading Multi-language - Script identification 2017



Identification of speech disorder in prodromal Parkinson's disease

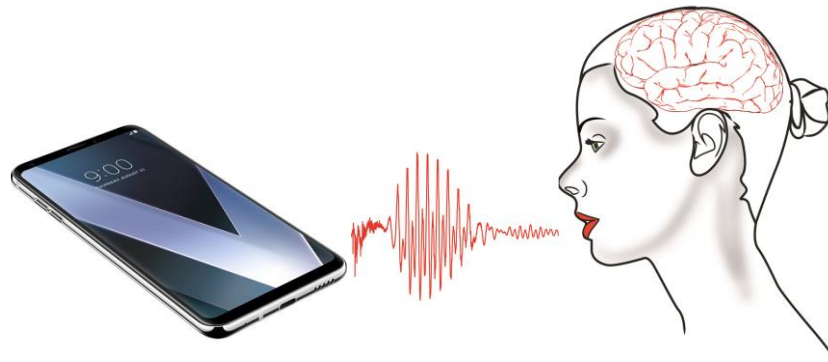
SAMI research group (<http://sami.fel.cvut.cz>), Dept. of Circuit Theory
Jan Ruzs, Jan Hlavnička, Tereza Tykalová, and Michal Novotný

We were first worldwide to develop a unique methodology on how to objectively detect preclinical Parkinson's disease via acoustic speech signal

Pilot results were continuously published in respected peer-reviewed journals:

- [Ruzs et al. Sleep Med 2016; 19:141-147.](#)
- [Hlavnička et al. Sci Rep 2017; 7:12.](#)
- [Ruzs et al. IEEE Trans Neural Syst Rehabil Eng 2018; 26:1495-1507.](#)

The findings raised international recognition, and thus we received for the continuation of the project prestigious USA funding by [Michael J Fox Foundation \(PI: Jan Ruzs\)](#) in collaboration with [7 centers of excellence](#) in sleep and parkinsonian research across Europe and North America.



Physical field-controlled manipulation of small robots

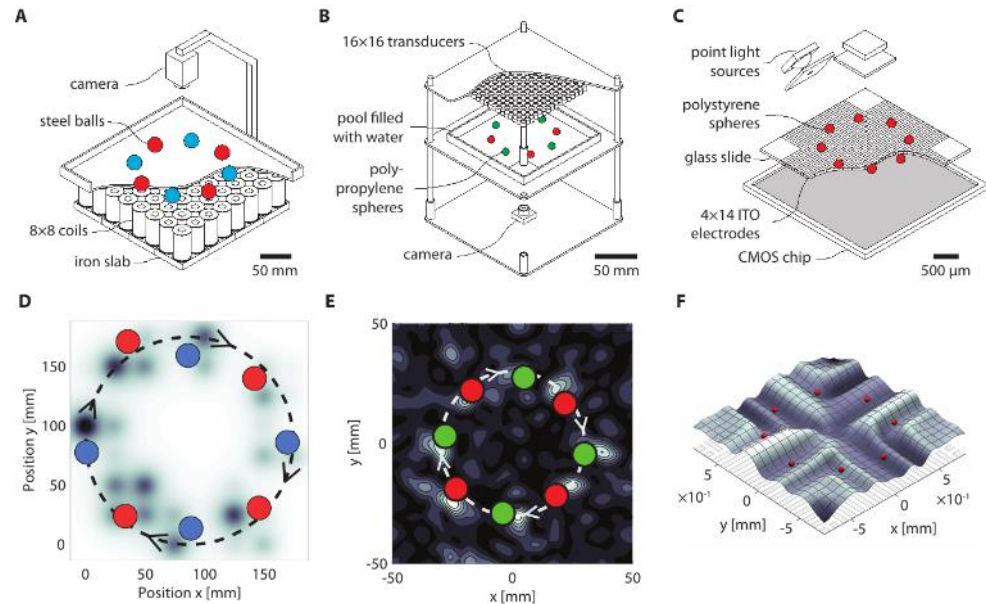
Dept. of Control Engineering, AA4CC group, Zdeněk Hurák

micro/milli-meter size „robots“:
up to 10 manipulated independently
planar arrays of generators of
magnetic, acoustic and electric fields
shaping the physical fields in real time
by solving nonconvex optimization
feedback by real-time visual tracking

Unique and unified approach to
real-time feedback manipulation with several small objects in plane
independently by shaping force fields through arrays of actuators

Applications: bioanalysis (cell manipulation) and intelligent materials (assembly)

Collaboration: FEMTO-ST, Besancon, F and IACH AV, Brno, CZ



papers in IEEE/ASME Trans on Mechatronics – Lab on a Chip
Physical Review E – Electrophoresis – Journal of Applied Physics

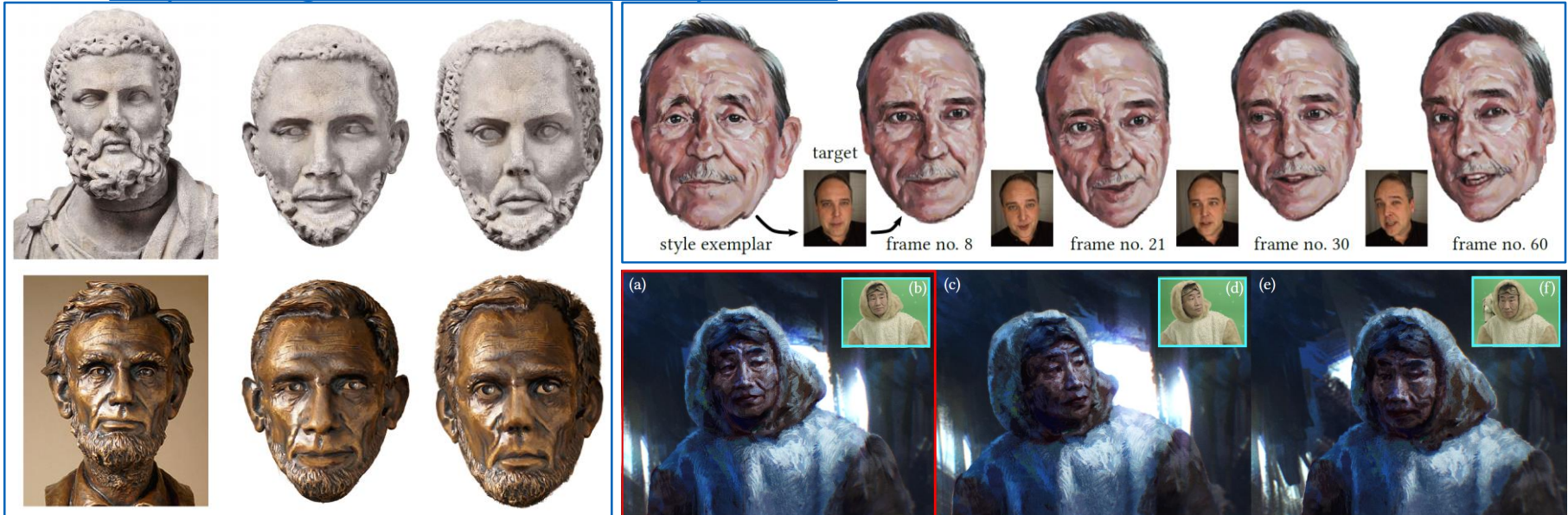
Example-based Stylization of Images and Videos

Prof. Daniel Sýkora - Dept. of Comp. Graph. & Interaction (DCGI)

A series of algorithms, patented methods (U.S.), and top-level publications (ACM Transactions on Graphics, SIGGRAPH) represents the unique achievements, currently the best in the area in the world scale.

Several solutions already implemented in the Adobe company products, enthusiastically welcome by creators from movie and imaging industry.

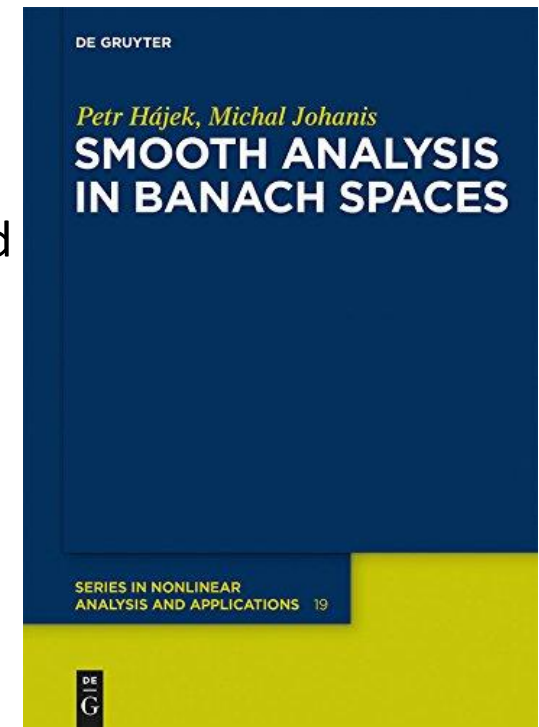
<https://dcgi.fel.cvut.cz/home/sykorad/>



Smooth Analysis in Banach Spaces

Petr Hajek, Dept. of Mathematics

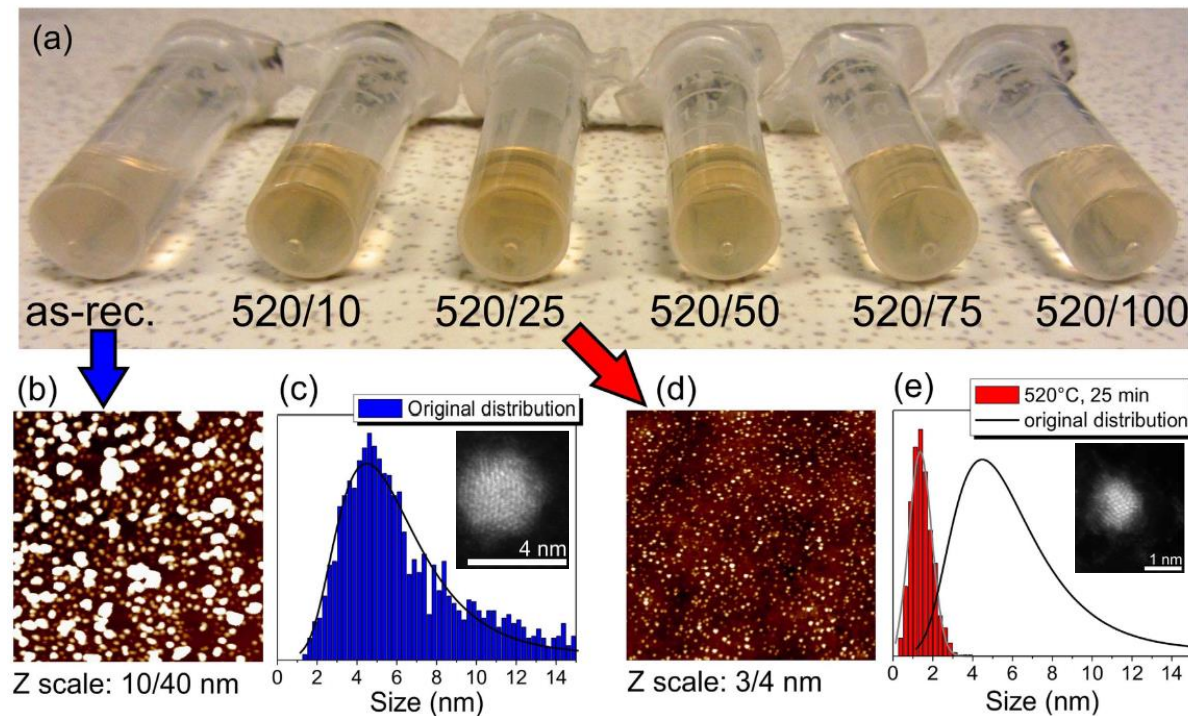
- [The book](#) is the **first systematic treatment** of smooth analysis in real Banach spaces.
- It brings **new views** of the role of polynomials in approximation nonlinear theory.
- The results stem from **original research of the authors** who have significantly contributed to the development of this area.
- Chosen as a **significant result of research in mathematics** by the Research, Development and Innovation Council, Government of the Czech Republic.
- **Rector's Award** for prestigious publication.



High-yield fabrication and properties of 1.4 nm nanodiamonds with narrow size distribution

K13102

<https://v3s.cvut.cz/results/detail/305696> [Scientific Reports 6 (2016) 2045]



Broad impact of the result:

- scaled up process, now NDs distributed to labs worldwide (CZ, Japan, Italy)
- helped us assemble EU teams in FET-Open project (DISOLAR), however not funded
- we employed such NDs further, showing full on/off switching of SiV color/spin centers in ultra thin 6 nm diamond films (ACS AMI 2017, IF 8.758, 17 citations so far)
- we showed that such molecular-sized NDs can control protein corona, published this year and selected for cover page in Carbon
- cited 31x in 4 years, incl. influential journals such as Carbon, ACS AMI, Small
- cited by the nanodiamond “guru” Eiji Osawa in two of his works (2018, 2019)

By analyzing thermal annealing process we achieved controllable size reduction of NDs down to 1.4 nm (mode size), narrow distribution (± 0.7 nm) with high yield while keeping diamond character and pushing the science and technology down to the fundamental stability limit of nanodiamonds (1 nm).

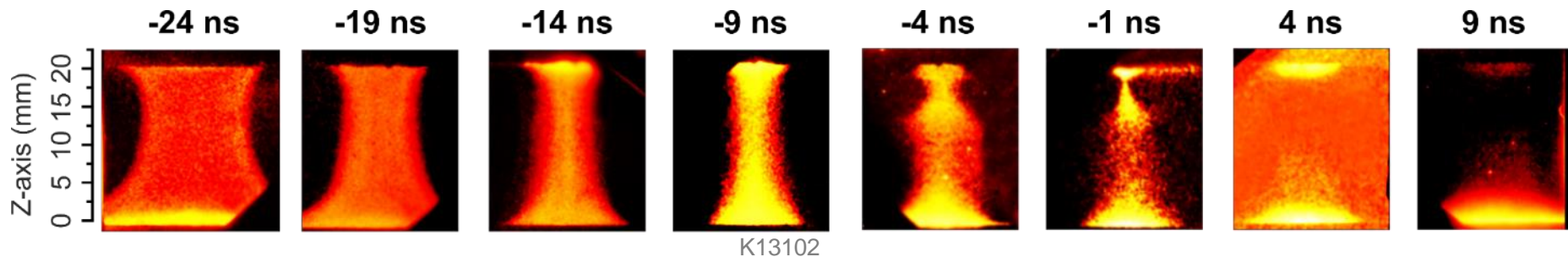
Ion acceleration mechanism to 60 MeV in mega-ampere plasma column

<https://v3s.cvut.cz/results/detail/322624>

K13102

soft x-ray images of plasma column imploding with 650 km/s velocity

New Journal of Physics
The open access journal at the forefront of physics



- Fast increase of impedance with a sub-nanosecond e -folding time leads to ion acceleration and neutron production in terawatt pulsed-power generator (GIT-12 in Tomsk, Russia)
- Increased neutron yields above 10^{13} at the current of 2.7 MA; deuterons reach 60 MeV
- Significant contribution to solution of one of the long-lasting problems in plasma

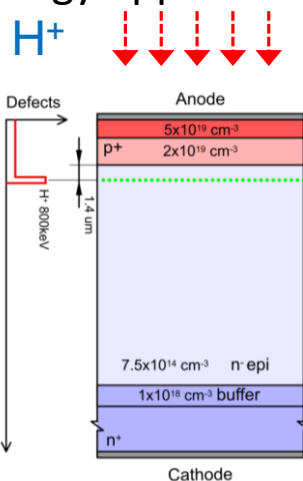
[Klir et al. *New J. Phys.* 20 \(2018\) 053064](#): >3000 downloads, cited 18x in 2 years.

- 60 MeV: highest ion energies in pulsed-power devices & comparable with state-of-the-art lasers
- Mechanism helps also explain production of energetic particles in space and solar plasmas
- Work resulted in collaboration, joint project and publications with US Naval Research Laboratory

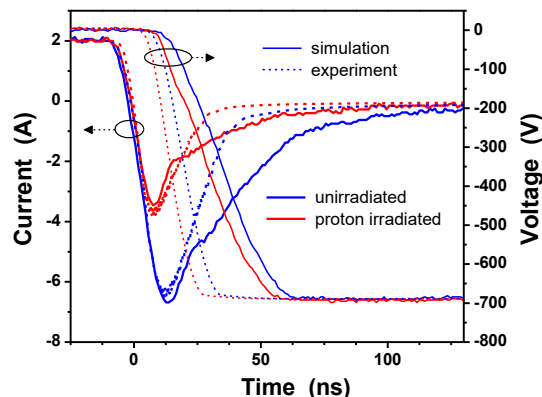
Novel SiC Power Device Technologies

Dept. of Microelectronics, Electron Device Group, Pavel Hazdra

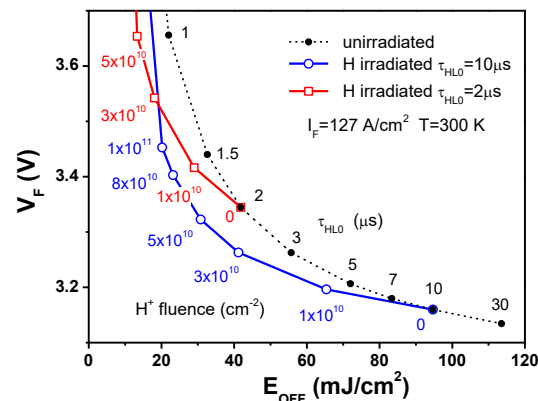
- Novel technique of Local Lifetime Control by proton irradiation was developed for high-voltage silicon carbide bipolar devices (Hazdra et al., *IEEE Transaction on Electron Devices*, 2018, DOI: 10.1109/TED.2018.2866763)
- The technique was applied in **collaboration** with **ASCATRON AB (S)** in production of 10 kV SiC power PiN diodes. It allows a significant reduction of turn-off losses and increase of the diode switching speed
- The research was conducted within **7 FP EU project SPEED** (silicon Carbide Power Technology for Energy Efficient Devices) supporting innovation in new power electronic technologies for energy applications – development of European silicon carbide power electronics



The principle



Diode Reverse-Recovery Waveforms

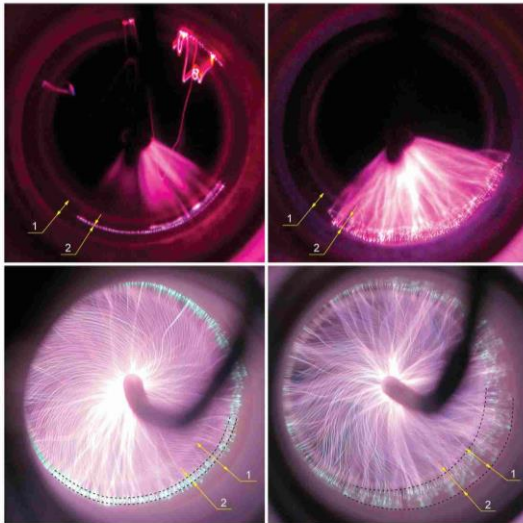


Static/Dynamic Losses Optimization

Spreading spark discharge via mutual action of acoustic and magnetic fields

K13102

scitation.org/journal/jap



Volume 126, Issue 8, 28 Aug. 2019

**DC-driven atmospheric pressure
pulsed discharge with
volume-distributed filaments in a
coaxial electrode system**

J. Appl. Phys. 126, 083301 (2019); doi.org/10.1063/1.5113950

- Spark discharge is principally very localized and uncontrolled event, thus difficult to make use of
- We showed that magnetic field can scan discharge filaments across the cross-section of a cylindrical tube while the acoustic field can spread the discharge along the length of the tube
- The **technology and physics** behind can help to advance the development of various plasma sources and reactors, i.e. for decontamination
- The work is **based on our European Patent EP3113582 “Stabilized and homogenized source of non-thermal plasma” (2017)**
- The Journal of Applied Physics selected the work **as the lead cover article** in its 8th issue (vol. 126)

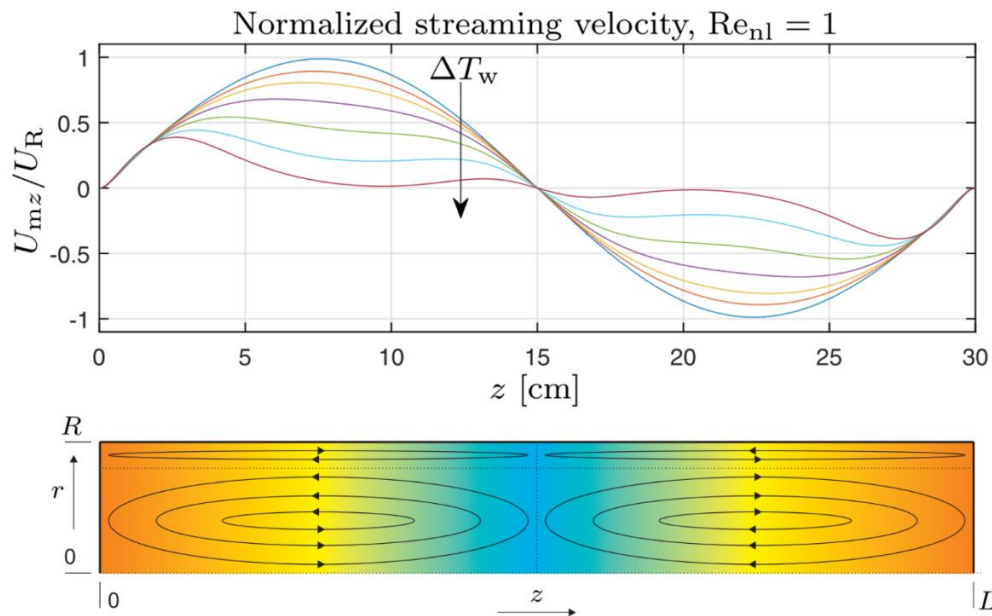


<https://v3s.cvut.cz/results/detail/332610>

<https://v3s.cvut.cz/results/detail/315075>

Influence of advective heat transport on acoustic streaming structure – Rayleigh revisited

K13102



- **Acoustic streaming** = net mean fluid flow that is generated by and superimposed on acoustic field
- **Lord Rayleigh** (1883) theoretically predicted sinusoidal-like pattern of acoustic streaming
- Modern measurements showed **deviation** from the Rayleigh's prediction in strong acoustic fields
- **We have revealed** its strong sensitivity on lateral temperature gradients and **universal mechanism** limiting the streaming velocities
- Unlike prior efforts, the proposed mechanism is consistent with experimentally obtained data
- The mechanism is highly important for various thermoacoustic and microfluidic **applications**
- Published in a series of two papers in JASA
- Cited in respected journals e.g. J. Fluid Mechanics



J. Acoust. Soc. Am. 2017 & 2018

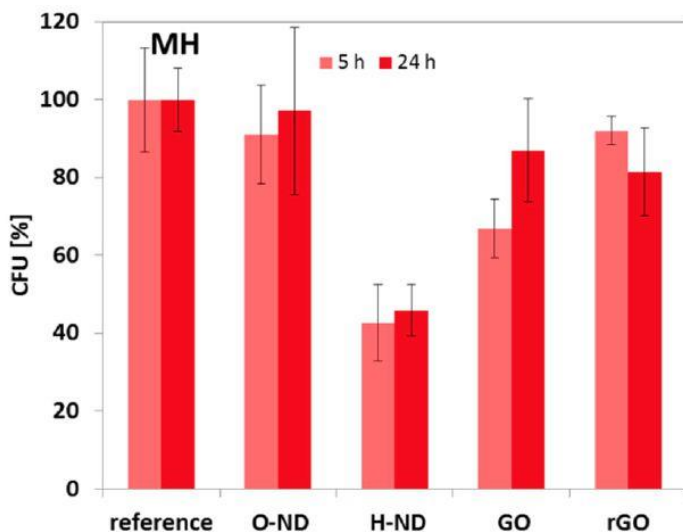
<https://v3s.cvut.cz/results/detail/312111>

<https://v3s.cvut.cz/results/detail/319375>

Inhibiting bacteria growth by carbon nanomaterials dispersed in cell culture media

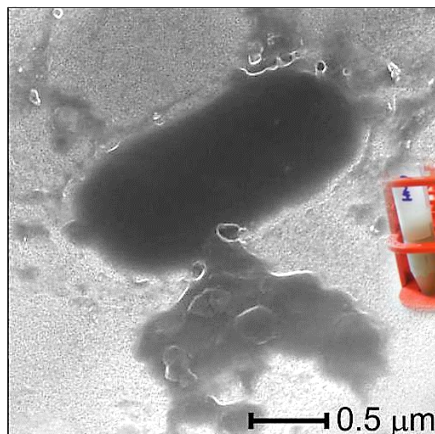
K13102

Colony forming units after 5 and 24 h in MH medium: H-nanodiamonds the most effective.



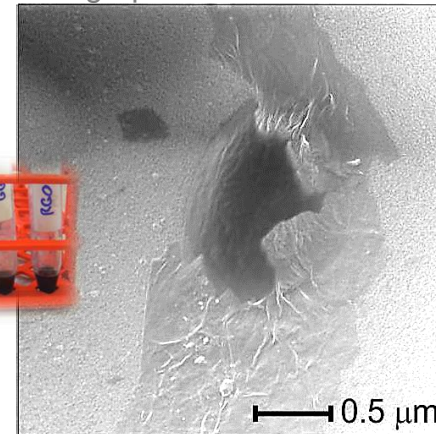
O-ND / H-ND - oxidized / hydrogenated 5 nm nanodiamonds
GO - graphene oxide, rGO - reduced graphene oxide flakes

E. Coli bacterium and H-nanodiamonds



Bacterium is damaged by H-NDs, cytoplasm is leaking.

E. Coli bacterium and graphene oxide



Bacterium is wrapped by GO sheets and gradually perishes.

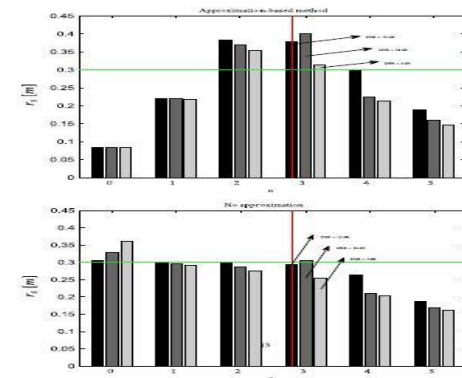
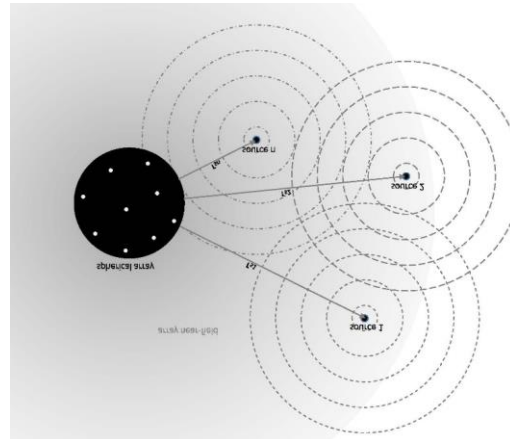
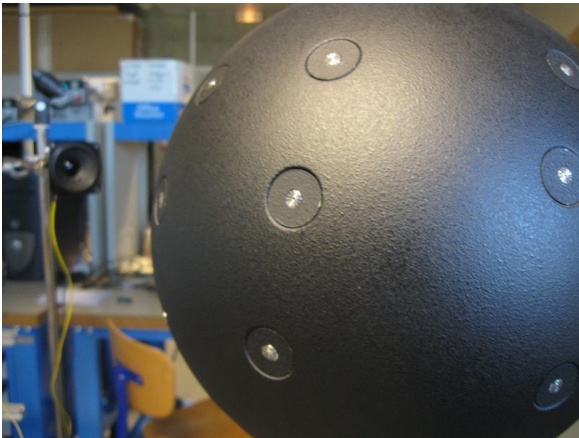
Inhibition of *E. Coli* growth by nanodiamond and graphene oxide **enhanced by Luria-Bertani medium**, [Nanomaterials 8 \(2018\) 140](#), > 1900 downloads and 14 citations in 2 years

Bacterial response to nanodiamonds and graphene oxide sheets, [Physica status solidi B 253 \(2016\) 2481](#), 13 citations in 4 years

Acoustic source distance determined from the spherical harmonics

K13102

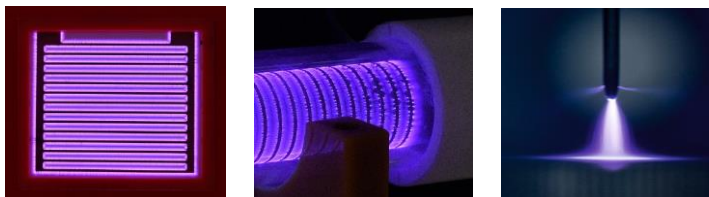
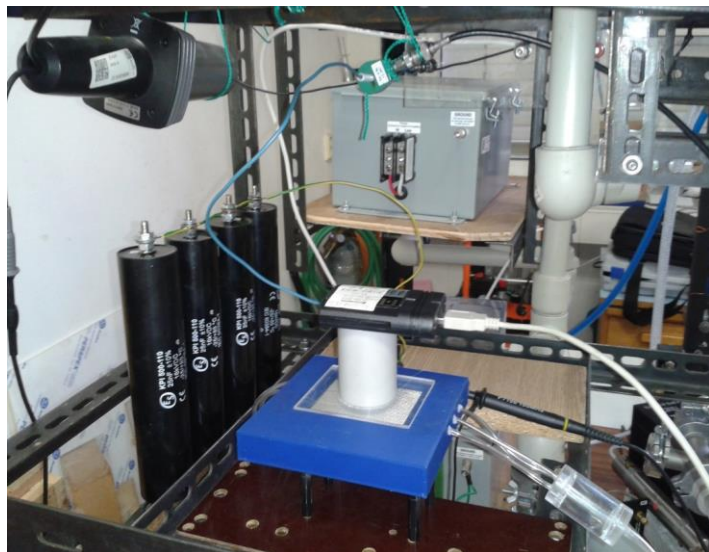
- Processing of signals measured by a spherical microphone array utilizing its **near-field information**.
- The processing, based on the spherical harmonics decomposition, was performed in order to investigate the radial dependent spherical functions and extract their argument – distance to the source.
- Using the **low-frequency approximation** of these functions, the source distance is explicitly expressed.
- Method was **tested for real data**: measured by a rigid spherical microphone array of radius 0.15 m consisting of 36 microphones and a small speaker as a point source.
- Published in D1 journal (2017) and also cited there: *Mechanical Systems and Signal Processing*



<https://v3s.cvut.cz/results/detail/307534>

Electrical discharges for energy efficient generation of active molecular species

K13102 + K13116



- Attention is focused on corona, and dielectric barrier discharges for the **generation of ozone and nitrogen oxides to kill bacteria, viruses (Covid-19) and for wound healing.**
- **Increased generation efficiency** of these species: usage of non-traditional materials, energization, optimization of electrode systems and air supply mode, application of photo-catalysts.
- Support from Technology Agency of the Czech Republic. TH03030432: *Advanced oxidation technology for water, disinfectants and environmental applications.*
- Czech **patent** No. 308279 (2020): *Method of ozone and other active particles generation and the apparatus for this purpose.*
- Since 2016 the research was published in 8 **scientific articles** that received > 20 **citations.**
- Research **collaboration** with Czech companies (Lifetech, Chemcomex) and the Czech Academy of Sciences.



chemcomex

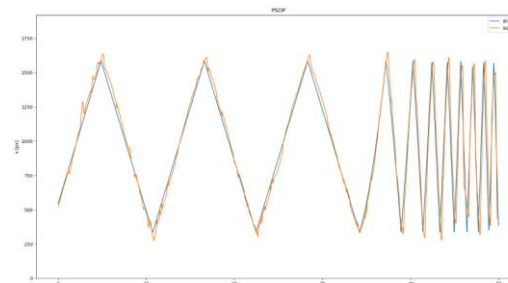
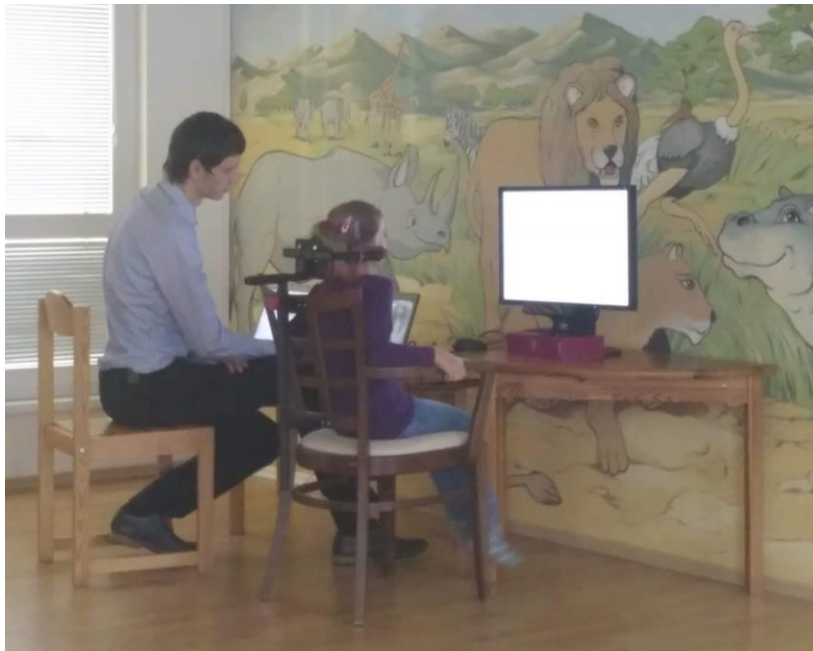
Lifetech
Ozone, UV and AOP Expert



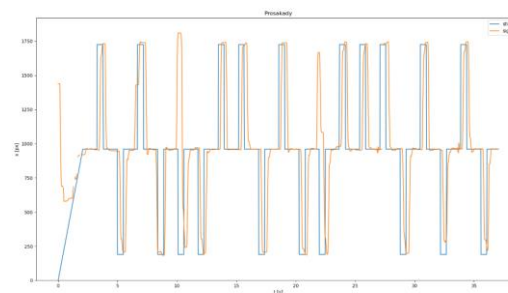
Eye-tracking and testing learning disabilities

M. Dobiáš, Department of economics, management and humanities

We have our own eye tracking technology which includes hardware and software. We have created a battery of oculometric tests for children in cooperation with the University of South Bohemia. We have verified the methodology of eye movement tested on a sample of approximately 1000 children. As a result, we are already able to identify eye movement problems, although we continue working on the more complex data analysis. Only then we will be able to state, whether a child needs assistance to improve e.g. his/her reading skills or not.



Zajíček
 Šel se naučit běhat, už prosil maminku, aby
 mohl lít na procházku. Sluníčko hrálo, ptáček
 zpíval, zajíček veselý poskakoval. Byl si tak
 si může sám, bez dohledu, přemýšlel vše, co
 se mu líbí. Porád nové věci mážážel – už toho
 měl přírod hlavičku a těšil se, že bude mamince
 vyprávět o velkém ptáku, o květinách,

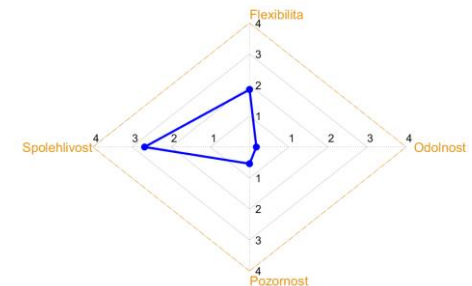
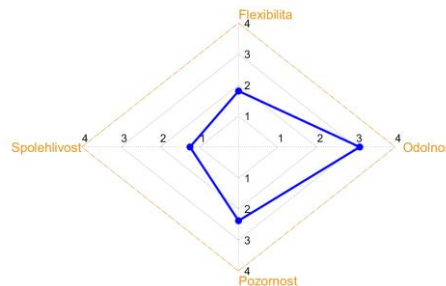
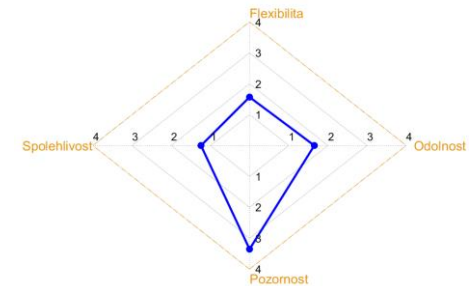


Zajíček
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 měl přírod hlavičku a těšil se, že bude mamince
 vyprávět o velkém ptáku, o květinách,

Virtual reality and eye-tracking for testing competencies in HR

M. Dobiáš, Department of economics, management and humanities

We have created several games in VR and we can identify selected competencies from eye tracking in relation to work safety. These include reliability, resilience, attention and flexibility. The created mathematical model is now being validated. The achieved results will be applied through the established personnel agency Motiv P on the Czech and Slovak market.



Microwave Ablation: Device Development and Treatment Planning

Department of Circuit Theory
Jan Šebek, Radoslav Bortel

Objective of our research is 2-fold. First, applicators for minimally invasive image guided treatment of tumors in lung, and liver with control of radiation pattern to prevent unnecessary thermal damage to surrounding healthy tissue.

[Sebek et al. Int. J. of Hypethermia 2017; 33.1: 51-60,](#)

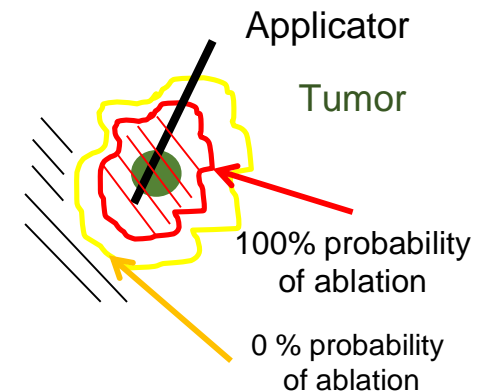
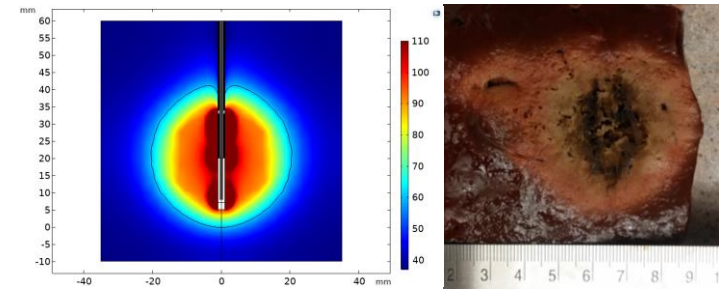
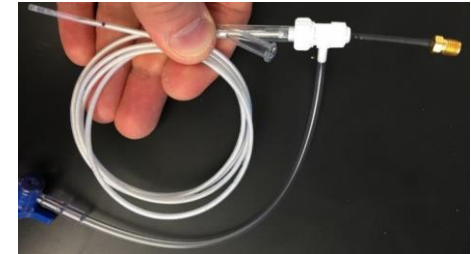
[Sebek et al. Journal of Medical Devices 2017; 11.3,](#)

[Sebek et al. ERJ Open Research; 2020; 6.4.](#)

Our second goal is to develop the patient-specific probabilistic treatment planning framework for guiding treatment parameters like applicator position, and energy dose to mitigate current challenges like local tumor recurrence.

[Sebek et al. Medical Physics 2016; 43.5: 2649-2661,](#)

[Sebek et al. Medical Physics 2019; 46.10: 4291-4303.](#)



Forecasting of epileptic seizures

SAMI research group (<http://sami.fel.cvut.cz>), the member of EpiReC (<http://epirec.cz>),
Department of Circuit Theory, and Department of Cybernetics
Jan Kudlacek, Jan Chvojka, Vojtech Kumpost, Radek Janca, et al.

The mechanism of seizure emergence and the role of brief interictal epileptiform discharges in seizure generation are two of the most important unresolved issues in modern epilepsy research. We found that the transition to seizure is not a sudden phenomenon, but is instead a slow process that is characterized by the progressive loss of neuronal network resilience. The external neuronal stimulation can prevent the loss of resilience and delay seizure incoming.

[W. Chang, J. Kudlacek, et al. Nature Neuroscience 2018; 21:1742-1752](#)

Stable system:




Unstable system:

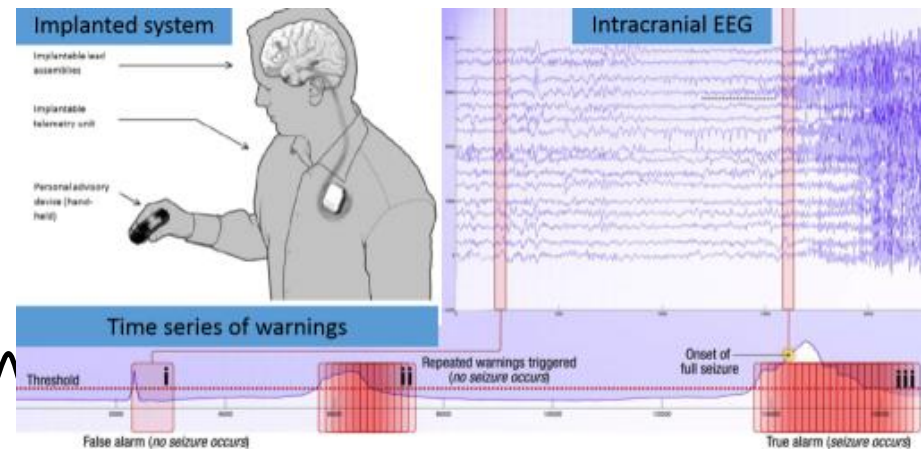


Oscillation around equilibrium (impuls response)

fast oscillation
low amplitude
fast damping



slow oscillation
high amplitude
slow damping

Hierarchical scheduling for Cloud-Radio Access Network (C-RAN)

Z. Becvar, Department of Telecommunication Engineering

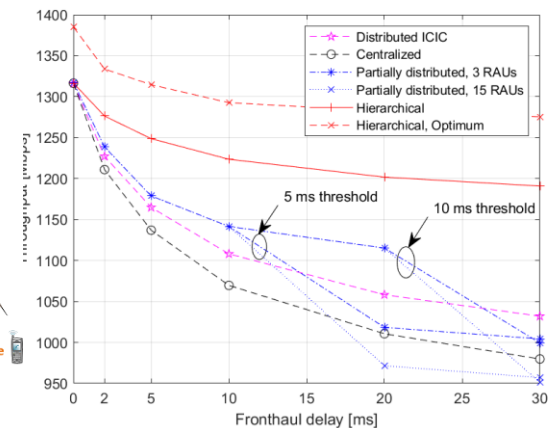
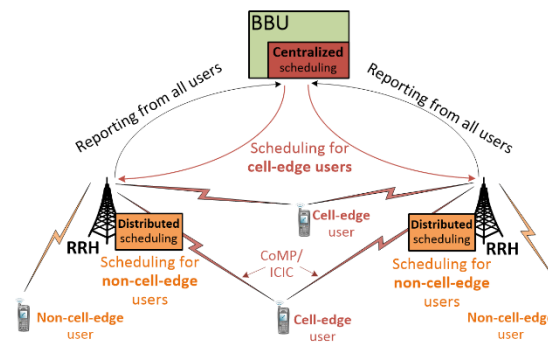
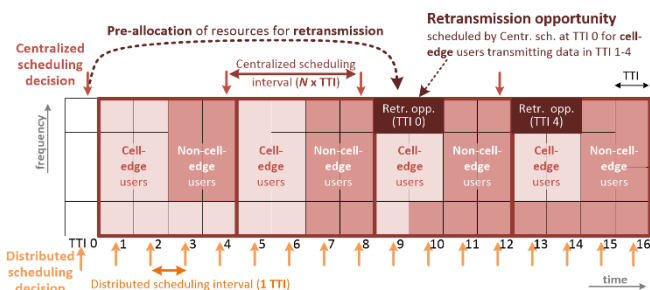
US patent + IEEE papers - 5Gmobile research lab (<http://5gmobile.fel.cvut.cz>)

C-RAN reduces cost and energy consumption of mobile networks

- **Communication functionalities split** between **centralized** baseband unit and **distributed** remote radio heads
- **Problem:** Additional **delay** (centralized ↔ distributed) → **performance degradation**

Solution

- Allocate resources at two tiers – **hierarchical scheduling**
 - **Centralized scheduler (C-Sc)**
 - **Distributed scheduler (D-Sc)**
- **Dynamic allocation of computing resources for scheduling**



Prediction of direct channel among devices (D2D communication)

Z. Becvar, Department of Telecommunication Engineering

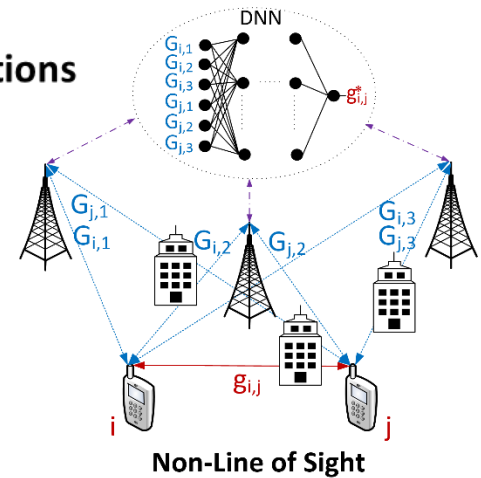
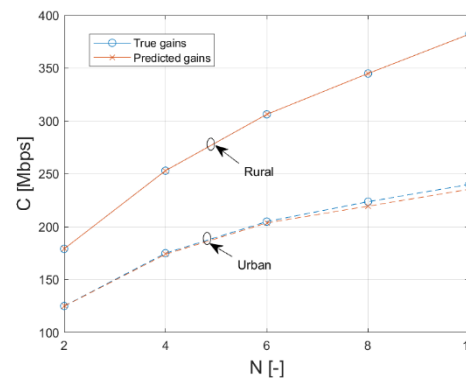
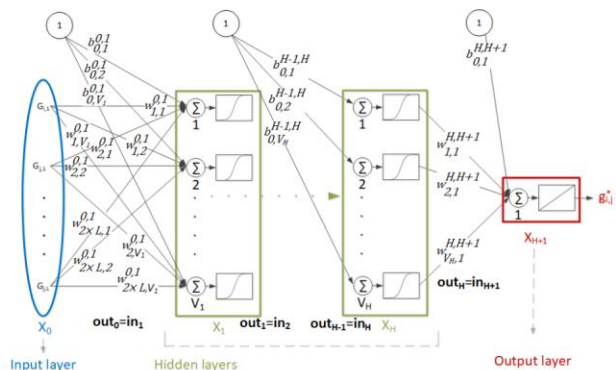
US patent + IEEE papers - 5Gmobile research lab (<http://5gmobile.fel.cvut.cz>)

Direct communication among devices (vehicles, IoT, machines,...)

- Knowledge of all channels among all devices ($N \times (N - 1)$ channels)
- Significant overhead to measure and report quality of all channels
- Limited number of communicating devices

Solution

- Predict direct channels among devices from channels to few base stations
- Deep neural networks for regression
- Close-to-optimal performance of radio resource management



Direct communication of (almost) any number of devices enabled

DARPA SubTerraean Challenge

prof. Tomáš Svoboda group, Dept. of Cybernetics

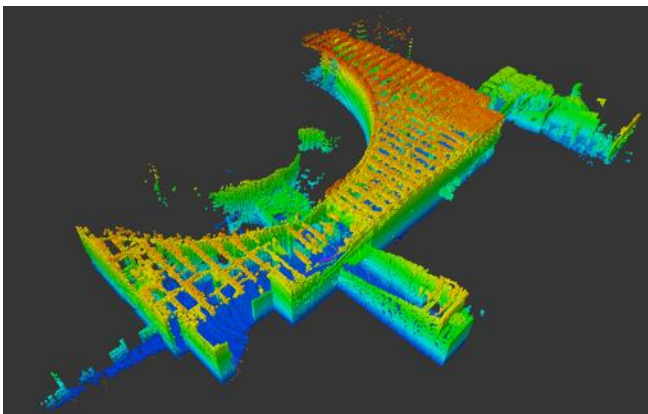
winning twice among self-funded teams
(twice 3rd overall)

Tracked, wheeled and flying robots (semi)autonomously exploring unknown underground



Dept. of Cybernetics and Dept. of Computer Science, and Uni LAVAL
60 min mission, go, explore, find, locate objects. No GPS, no Wifi ...

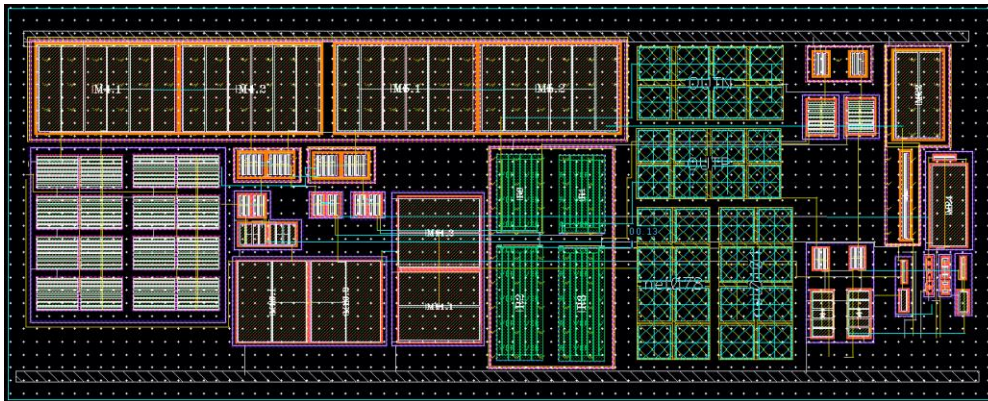
<http://robotics.fel.cvut.cz/cras/darpa-subt/>



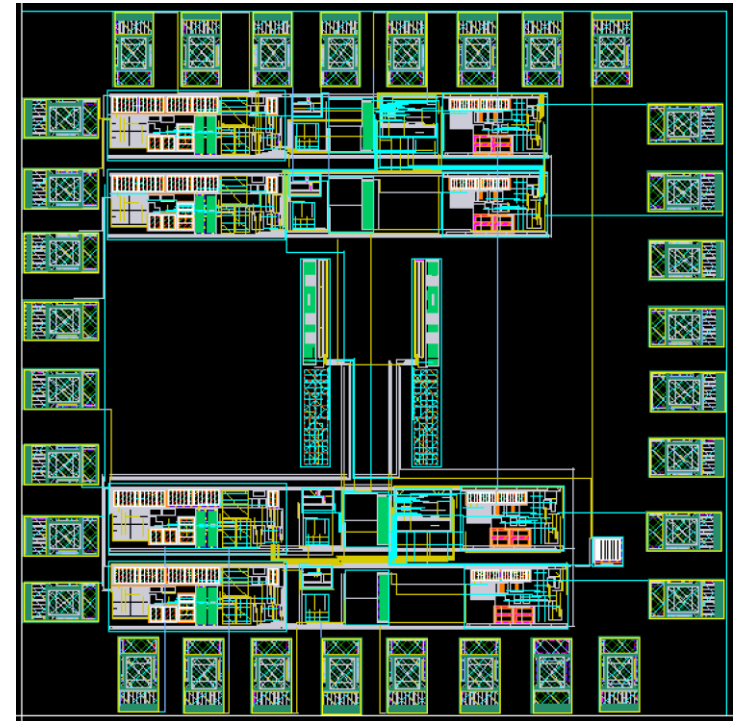
MEMS sensors with optical scanning

Microsystems Group (Janíček, Husák), Department of Microelectronics

- Within the ESO MEMS project CTU developed a layout of data processing circuit for MEMS system with optical scanning.
- It uses a X-Fab 180 nm technology.
- The result will be applied at Honeywell, Inc.



Partial layout



Complete layout

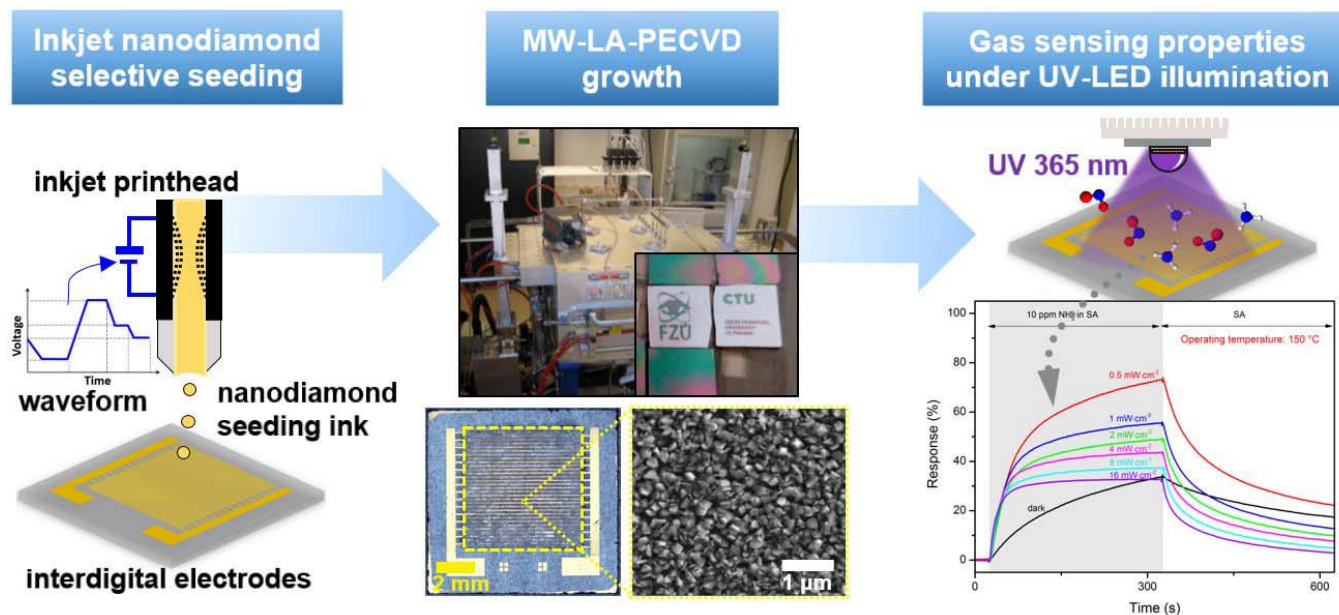


Ink-jet printed sensors

Electron Device Group, J. Voves, Department of Microelectronics

Realization and optimization of novel gas sensing structures using flexible materials and ink-jet printing technique. Characterization of interdigital resistive sensors by electrical and optical methods. Simulation of interaction of gas molecules with sensor surface using quantum models.

This basic research is funded by EU OP RDE project Centre of Advanced Applied Sciences (CAAS) and results have been presented in top scientific journals Physica E, IEEE Sensors .



Large Core Optical Planar Splitters

Opto Electronics Group, Václav Prajzler, Department of Microelectronics

- Development of Large Core Optical Planar Splitters by 3D print technology
- Large Core Optical Planar Splitters are used together Plastic Optical Fibers (POF) as a simple solution for data transmission in short-range data communications such as home or office networks, automotive or locomotives optical communications.

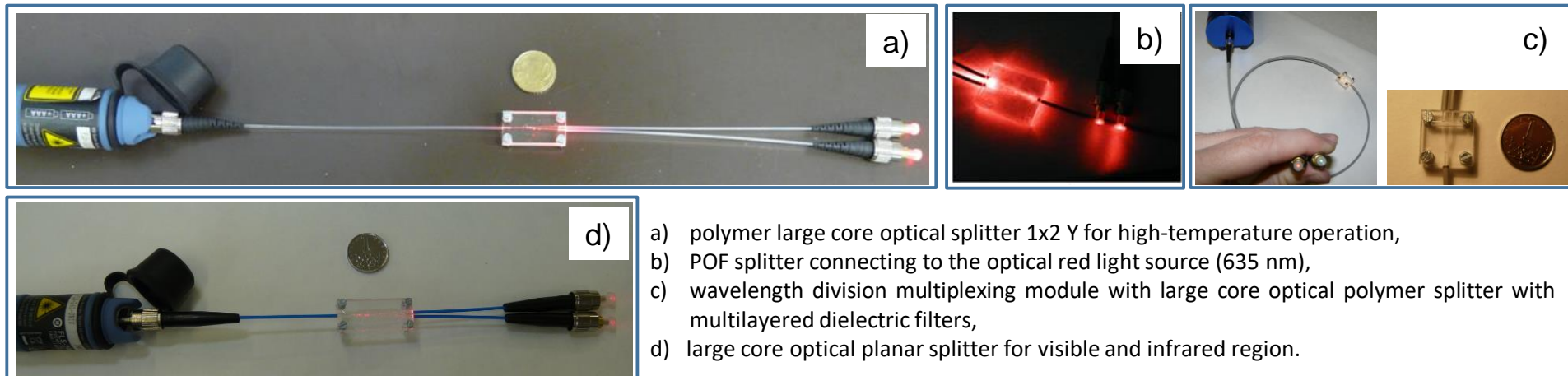
Published papers:

Prajzler, V. et al. Large core plastic planar optical splitter fabricated by 3D printing technology. *Optics Communications*. 2017, (400), 38-42. ISSN 0030-4018. DOI 10.1016/j.optcom.2017.04.070.

Prajzler, V. et al. Wavelength division multiplexing module with large core optical polymer planar splitter and multilayered dielectric filters. *Optical and Quantum Electronics*. 2017, 49(4), ISSN 0306-8919. DOI 10.1007/s11082-017-0960-4.

Prajzler, V. a J. Zázvorka. Polymer large core optical splitter 1x2 Y for high-temperature operation. *Optical and Quantum Electronics*. 2019, 51(7), ISSN 0306-8919. DOI 10.1007/s11082-019-1933-6.

Patent: Optical planar multimode POF branching point, 305196, České vysoké učení technické v Praze Fakulta elektrotechnická. Optická planární mnohavidová rozbočnice. Authors: V. Prajzler, M. Neruda a V. Jeřábek.

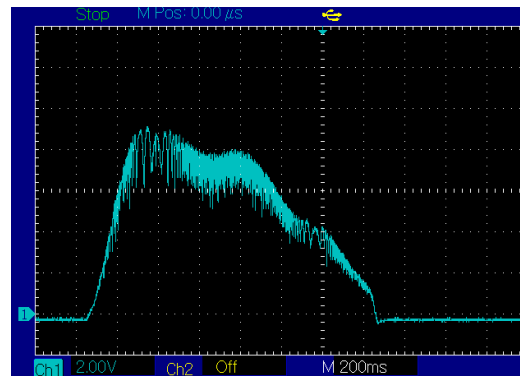
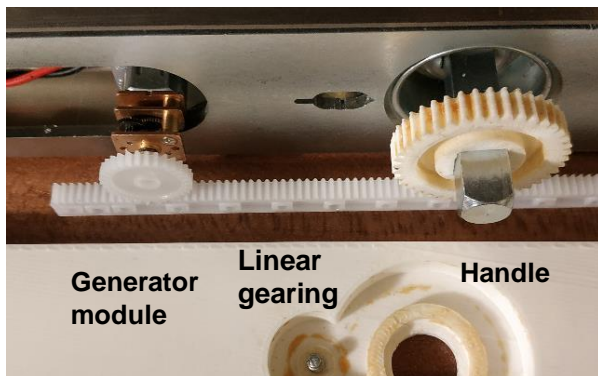


- a) polymer large core optical splitter 1x2 Y for high-temperature operation,
 b) POF splitter connecting to the optical red light source (635 nm),
 c) wavelength division multiplexing module with large core optical polymer splitter with multilayered dielectric filters,
 d) large core optical planar splitter for visible and infrared region.

Smart Access Control for Smart Buildings

Microsystems group (Janíček, Husák), Department of Microelectronics

- Within the SACON project CTU developed a system integrateable into regular door handle with energy harvester for powering the smart lock.
- It uses gear with high ratio which is driven by the door handle itself. Just one turn can generate enough energy for generating enough energy for powering the integrated power management circuit which stores the energy in supercapacitors or batteries.
- The hardware will be compatible with industry standards of our project partners (EVALAN, IMA), the hardware is intended for commercial use.



Waveform of generated voltage: 2V/div., 200 ms/div.

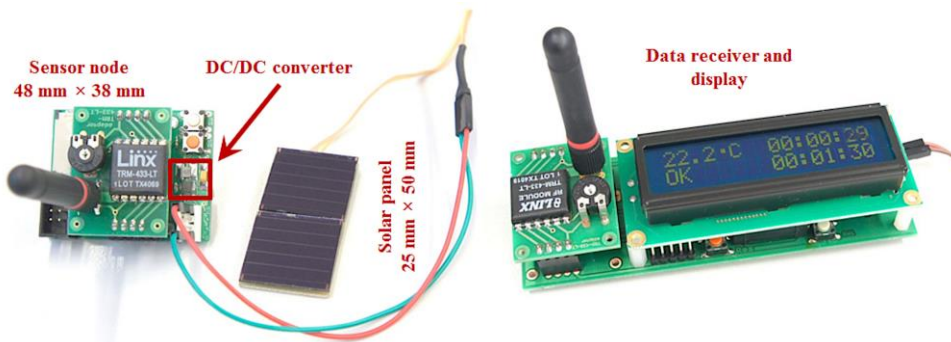


Energy harvester module

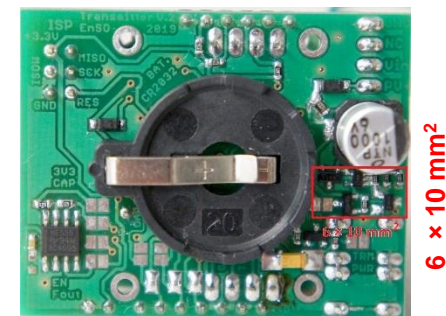
Wireless sensor nodes powered by energy harvesting

Microsystems Group (Bouřa, Husák), Department of Microelectronics

- Within the EnSO EU project CTU developed wireless sensor nodes that can be powered just using the energy from the surroundings.
- Successfully tested with small photovoltaic panels at indoor illumination, piezoelectric transducer for harvesting the vibrations and Peltier cells for powering by heat (human body, waste heat, sun, etc.).
- Hardware part of the energy harvester occupies just $6 \times 10 \text{ mm}^2$ on PCB and price of the components is 30 times lower than price of the commercially available equivalent module (2.2 € vs. 67 €) which allows mass applicability e.g. in the IoT smart grids and ubiquitous sensors.



Developed sensor node with energy harvesting circuit and the receiver.



Energy harvester on sensor node PCB

Revolutionary certification methodology for flight control systems Dept. of Control Engineering - Martin Hromčík group

Collaboration with Honeywell Aerospace in the years 2015-2020

→ [BendixKing AeroCruz 230](#) product released Summer 2020

For the first time ever, [AML STC](#) (Approved Model List – Supplement Type Certificate) was received for an autopilot unit

The system certified for more than 60 aircraft types while full certification flights for only three types were done

Accompanying [analysis developed by CVUT](#) convinced certification authorities (FAA, EASA) that heavily reduced number of flight tests is sufficient

Reduced development costs and rapid marketing of new autopilots

Reported by [Avionics News](#), Sept 2020

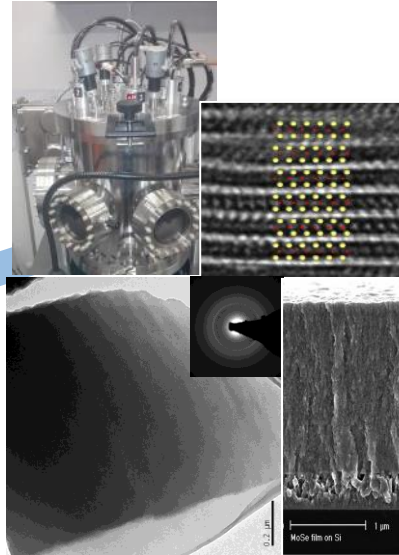


From atoms to fighters: revolutionary solid lubricants

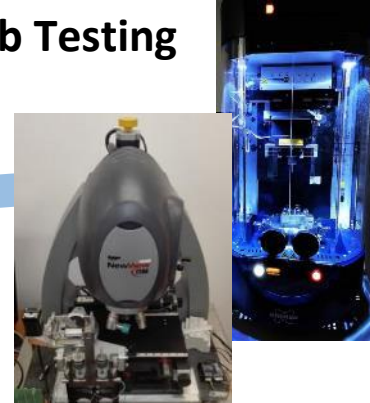
Dept. of Control Engineering - Tomáš Polcar group

Key papers:
Nature Comm 2020
Phys Rev B 2019, 2020
ACS Appl Mat Int 2019
Nanoscale 2018

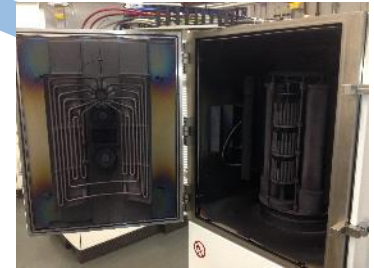
Material Fabrication



Lab Testing



Process Up-scale



Deposition on real part



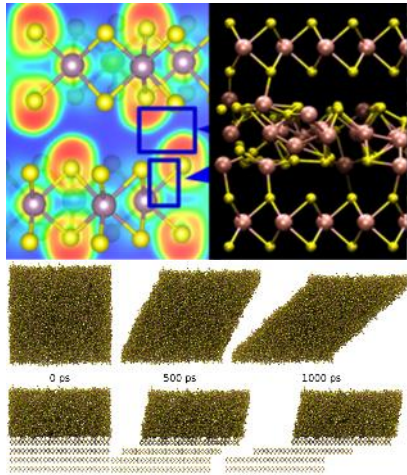
Industrial testing



Application: solid lubricant on actuator for L39 NG



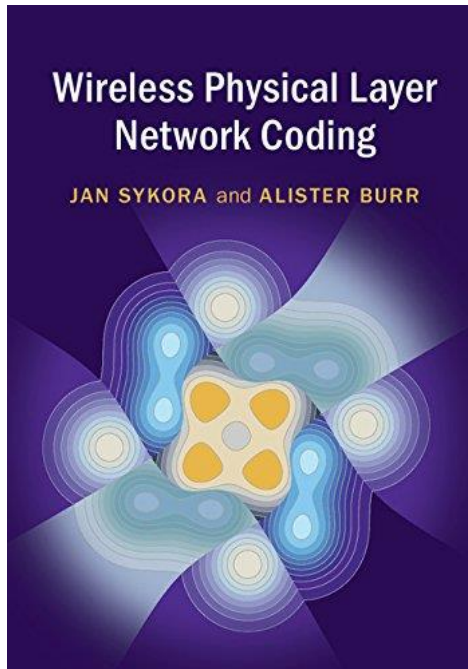
Atomistic simulations



Wireless Physical Layer Network Coding

Department of Radioelectronics, DiRaC, Jan Sýkora

(Jan.Sykora@fel.cvut.cz)



Sýkora, J. (CTU in Prague), Burr, A. (University of York, UK):
Wireless Physical Layer Network Coding, Cambridge
University Press, 2018.

<https://doi.org/10.1017/9781316156162>

- Comprehensive **theoretical monograph** – **mathematical grounds** for **physical layer network coding** and **signal processing**
- **Novel research results**, e.g., **capacity coding theorems** (achievability, converse) for hierarchical decode and forward strategy (chapter 5.7), design of **Network Coded Modulation** for **imperfect hierarchical side-information** (chapter 8), **Joint Hierarchical Interference** processing (chapter 9.4), and **WPNC coding** for complex **stochastic networks** (chapter 10), ...
- **FP7-ICT DIWINE** - Dense Cooperative Wireless Cloud Network (2013-2015)
- CTU in Prague **Rector's Award** for Prestigious Publication

Fluxgate magnetometer with 1 pT noise

Mattia Butta and Michal Janošek, Department of Measurement

Novel type of fluxgate sensors based on amorphous wire achieved noise of 1 pT/ $\sqrt{\text{Hz}}$ at 1 Hz, which is the lowest noise reported for this type of room temperature vectorial magnetic sensor

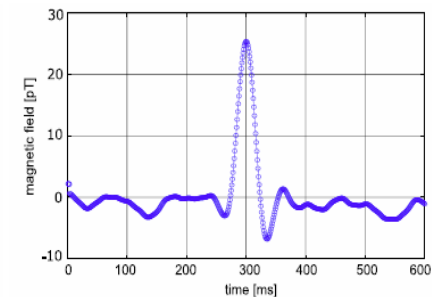
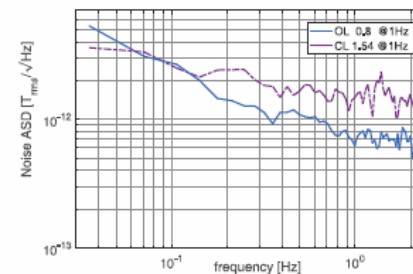
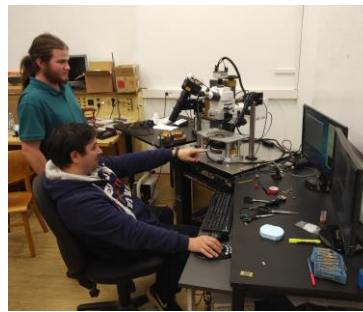
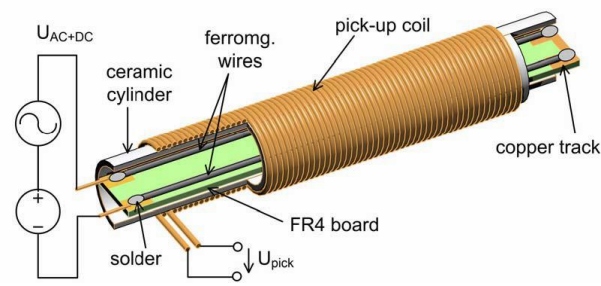
Janošek, M.; Butta, M.; Dressler, M.; Saunderson, E.; Novotný, D.; Fourie, C.
1-pT noise fluxgate magnetometer for geomagnetic measurements and unshielded magnetocardiography. IEEE Trans. Instr. Meas. 2020, 69(5), 2552-2560

Butta, M.; Vazquez, M.; Del Real, R.; Calle, E.

[Dependence of the noise of an orthogonal fluxgate on the composition of its amorphous wire-core](#)

AIP Advances. 2020, 2020(2), 025114-1

ORTHOGONAL FLUXGATE SENSOR. M. JANOŠEK and M. BUTTA. European Patent Office.
[Patent EP3460499](#). 2020-05-22.



Multimedia transmission quality subjective testing with parallel task

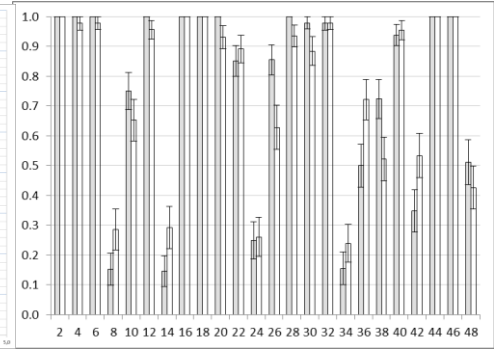
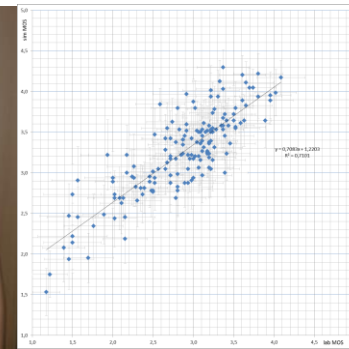
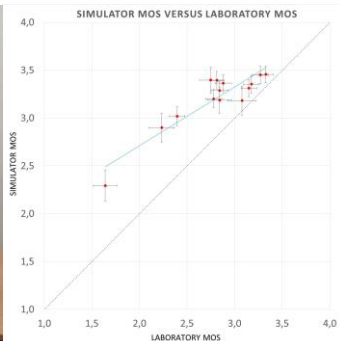
Jan Holub, Hakob Avetisyan, Dept. of Measurement

Novel subjective testing methodology designed to mimic multi-tasking environment. The resulting international recommendation is the first methodology for multimedia transmission quality subjective testing that deploys parallel task world-wide.

HOLUB, J., O. SLAVATA, and H. AVETISYAN. [ETSI TR 103 503 : Speech and Multimedia Transmission Quality Procedures for Multimedia Transmission Quality Testing with Paralell Task including Subjective Testing](#) European Telecommunication Standardization Institution 2018

AVETISYAN, H., J. HOLUB, and O. SLAVATA. [Low Bit-rate Coded Speech Intelligibility Testing in Czech Language using Parallel Task](#). Journal of Audio Engineering Society. 2020, 2020(3), ISSN 1549-4950.

HOLUB, J., et al. [Subjective audio quality testing, with tasting and car driving as parallel task](#). IEEE Access. 2018, 60769-60775. ISSN 2169-3536.



Lightdrum: A portable device for texture measurement (BTF, BRDF)

prof. V. Havran – Dept. of Comp. Graph. & Interaction (DCGI)

- A unique, accurate, and portable device. A result of a cooperation of two CTU faculties. CZ patent (2018), U.S. patent (2020).
- <https://dcgi.fel.cvut.cz/projects/lightdrum/>
- Havran, V. et al.: [Lightdrum-Portable Light Stage for Accurate BTF Measurement on Site](#). Sensors. 2017, 17(3), 1-57. ISSN 1424-8220.

