Den otevřených dveří
pro zájemce o doktorské studium
na ČVUT FEL

Praha
7. dubna, 2022

Program

1. Úvodní slovo - P. Páta, děkan FEL
2. Představení vědy a doktorského studia na ČVUT FEL - M. Polívka, proděkan DSaV
3. Medailonky úspěšných absolventů - proděkan DSaV
4. Diskuse za účasti školitelů, předsedů OR, vedoucích kateder, absolventů, ..

Věda na ČVUT FEL

Věda

Poslání – poskytovat **vzdělání** a provádět **vědecký výzkum** na **světové úrovni** v oblastech elektrotechniky (EE) a informatiky/počítačových věd (CS) s přesahem do přírodních, lékařských, ekonomických a humanitních věd:

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, ..

QS WORLD UNIVERSITY RANKINGS **ČVUT**, 2022: #403 (2021: #432, 2020: #498, 2019: #531-540)
FEL, 2022: EE (#201-250), CS (#201-250)

Vládní hodnocení VO, M17+, mezinárodní hodnotící panel
2020
Engineering & Technology
„Excellent" (1./5), 252/267 b.
FEL 1. ze 13 součástí ČVUT

Žebříček Hospodářských novin
2015-16
FEL nejlepší informatická fakulta v ČR

Věda

Silné stránky

- Zavedené vědecké týmy (28 na https://fel.cvut.cz/cz/vv/tymy/)
- Publikační standardy vysoké kvality (IF časopisy, konference CORE A*, A)
- Špičkové vybavení laboratoří (HW, SW)
- Mezinárodní spolupráce (projekty, společné týmy, stáže)
- Ocenění (jednotlivci, týmy)
- Výsledky dotažené ke komercionalizaci (prodané licence, spin-off, start-up)

Výsledky

Typ výsledku / rok	**2021**	**2020**	**2019**	**2018**	**2017**	**2016**
WoS IF časopis. články[1]	353	344	323	316	306	280
WoS citace[1]	9 956	9 221	10 164	8 603	7 801	6 976
patenty, US+Jap+EU / Celkem	1 / 11	9 / 15	12 / 20	6 / 10	4 / 12	5 / 12

[1] Podle V3S, duben 2022, bez autocitací

~ **1/3** vědeckých výsledků ČVUT, 2021 (V3S)

Publikace Jimp: 26 % abs., **30 %** přepočt. autorské podíly

Citace: 38 % abs., **41 %** přepočt. autorské podíly

FACULTY OF ELECTRICAL ENGINEERING
FROM ELECTRONS TO CLOUDS

CZECH
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IN PRAGUE

Výběr z nejlepších R&D výsledků a úspěchů

7 příkladů demonstrující:

- podporu tuzemskými/zahraničními grantovými agenturami či nadacemi,
  - zapojení do mezinárodních spoluprací/nadnárodních projektů,
    - prezentaci a zveřejňování výsledků, společenský dopad,
      - patentovou ochranu a komercionalizaci výsledků,
        - získaná ocenění, ..

Dalších 26 v příloze

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

- 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

Identification of speech disorder in prodromal Parkinson's disease

SAMI research group (http://sami.fel.cvut.cz), Dept. of Circuit Theory
Jan Rusz, 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:

- Rusz et al. Sleep Med 2016; 19:141-147.

- Hlavnička et al. Sci Rep 2017; 7:12.

- Rusz 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 Rusz) in collaboration with 7 centers of excellence in sleep and parkinsonian research across Europe and North America.

THE MICHAEL J. FOX FOUNDATION
FOR PARKINSON'S RESEARCH
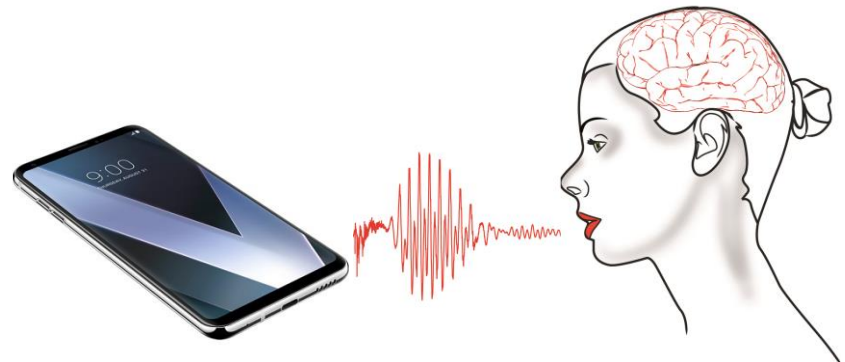
Method for accurate automated non-invasive measurement of blood pressure waveform Dept. of Physics

180

BP [mmHg]

80

0   time [ms]   1100
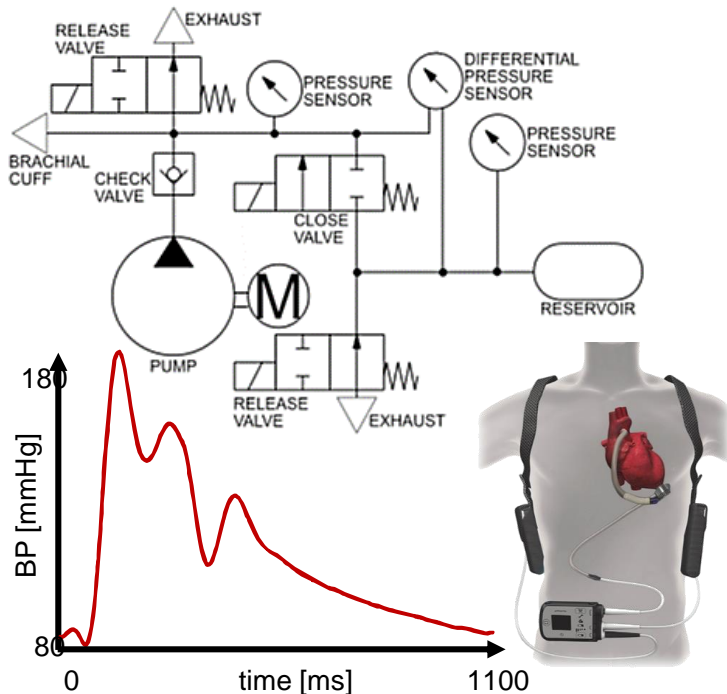
Validated against the gold standard of PWV measurement.

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

- **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

9

AToM – Antenna Toolbox for MATLAB
Dept. of Electromagnetic Field, Miloslav Čapek

- antenna analysis and design with unique novel features
- based on fundamental research*), ongoing support&development
- licences sold worldwide (*Sandia Labs.*, *Kathrein*, *Futurewei*, ...)
- free demo version available (452 users within 30 months)
- almost 20k downloads of corresponding white papers
- project has opened collaboration with, *e.g.*, *ESI Group*
- developed & owned by CTU, see **antennatoolbox.com**

Designer, solver settings, analysis of results.
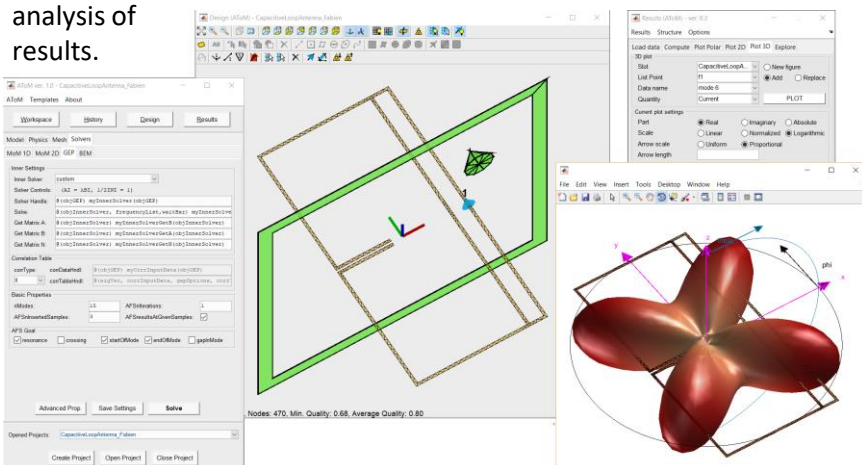
Modal analysis of car chassis.
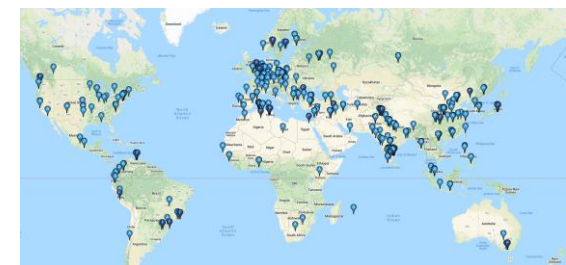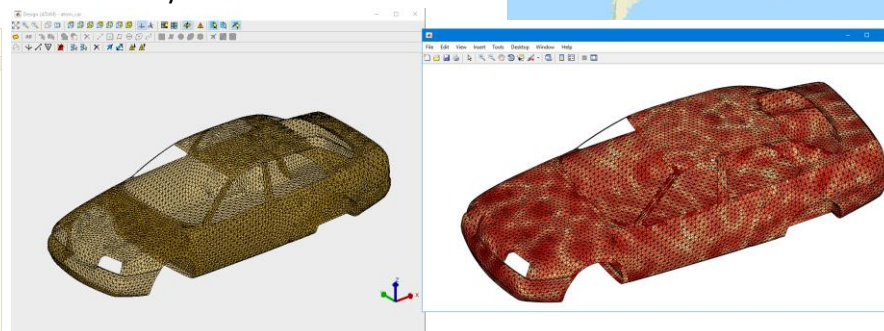
Where our users reside…

SIMToolbox – Live cell microscopy beyond the diffraction limit
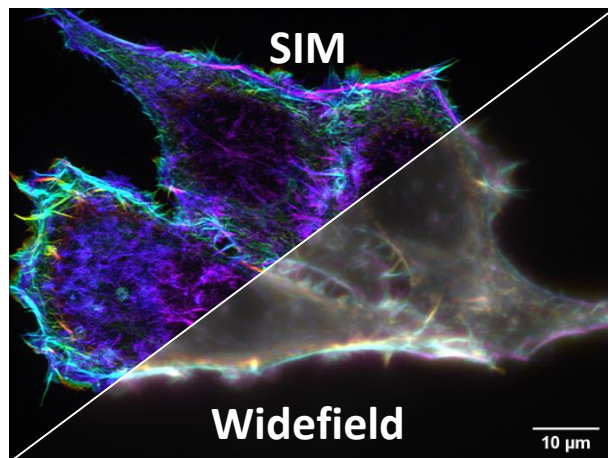
Dept. of Radioelectronics, MMTG, Miloš Klíma

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**)

SIM

Widefield

10 μm

International collaboration:
EPFL, Switzerland
UCCS, Colorado, USA
UNI Bielefeld, Germany
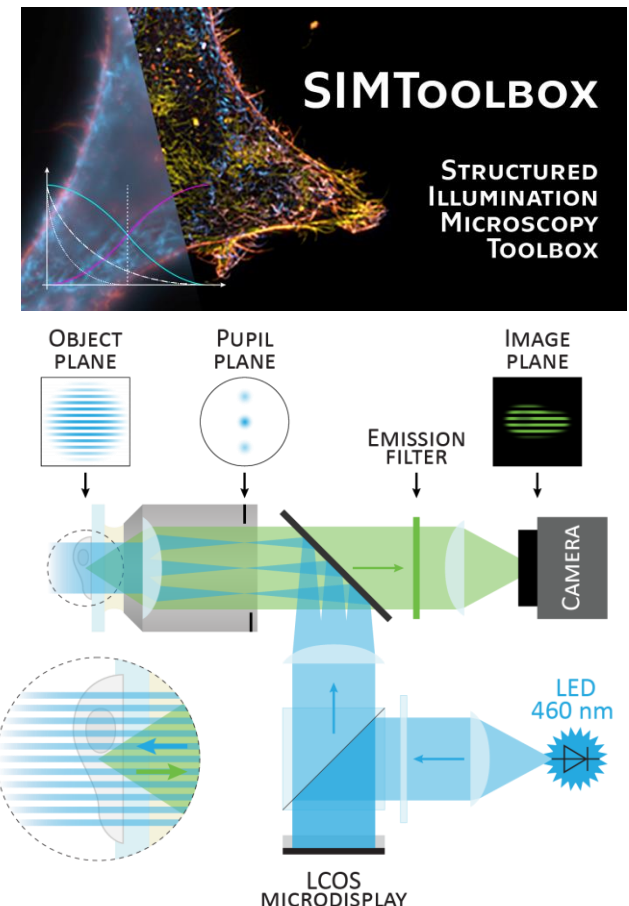
Associated publications:
Opt. Express 2014 (Q1)
Bioinformatics 2016 (Q1)
GigaScience 2019 (Q1)

SIMTOOLBOX
STRUCTURED ILLUMINATION MICROSCOPY TOOLBOX

OBJECT PLANE   PUPIL PLANE   IMAGE PLANE   EMISSION FILTER   CAMERA   LED 460 nm   LCOS MICRODISPLAY

Received grants/projects:
Jakub Pospíšil (2018-2021, ESR) – **project DeLIVER**
H2020 Innovative Training Network, No. 766181

SIM setup built and operated at UCCS

# 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)
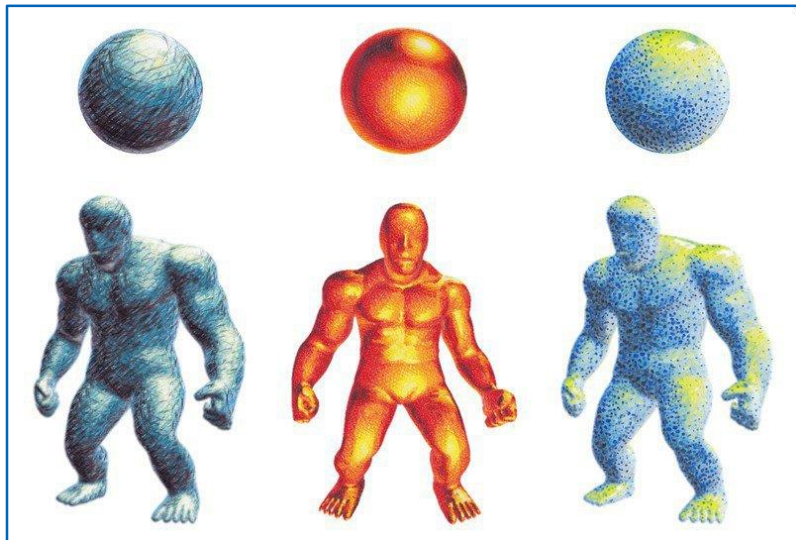
Collaboration: FEMTO-ST, Besancon, F and IACH AV, Brno, CZ
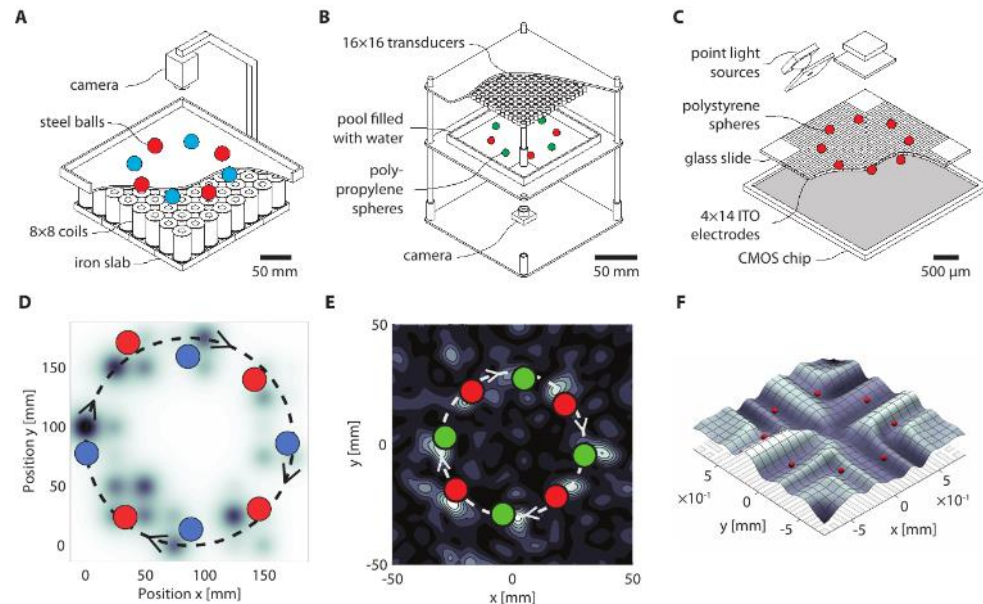
papers in IEEE/ASME Trans on Mechatronics – Lab on a Chip
Physical Review E – Electrophoresis – Journal of Applied Physics

Example-based Stylization of Images and Videos
Dept. of Computer Graphics & Interaction (DCGI), prof. Daniel Sýkora's group

- **8** SIGGRAPH papers

- **6** US patents

- **4** free Software Tools
  (EbSynth, StyleBLIT, FaceStyle, StyLit)

- **2** companies have included results
  (Adobe, Snap)
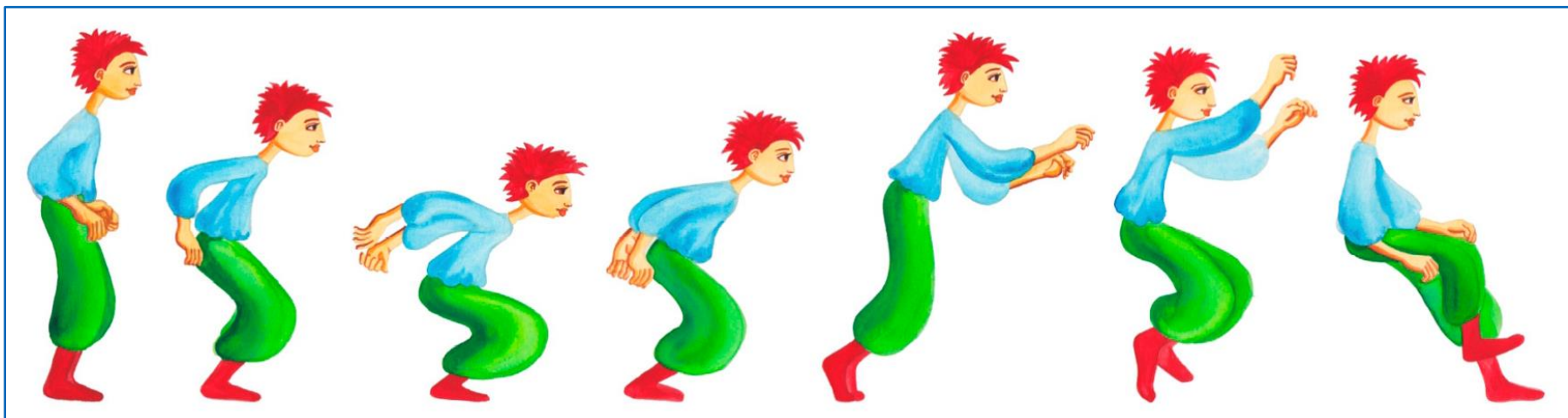
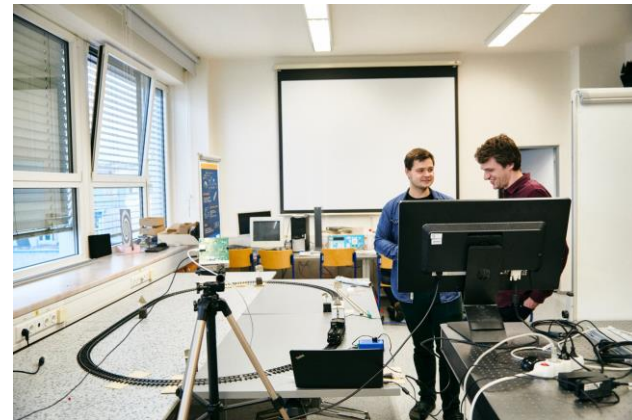# Doktorské studium
na ČVUT FEL

Doktorské studium - přehled

- **Ph.D.**, "Doctor of Philosophy", „doktorát",
  nejvyšší stupeň VŠ vzdělání
  „philosophiae" – z latiny, v řečtině „láska k moudrosti"

- **Obsah:** vědecký výzkum na „disertabilním" tématu
  pod vedením školitele
  (*mající potenciál nalezení původních výsledků překonávající současný stav poznání*)

- **Forma**: prezenční/kombinovaná

- **Standardní délka**: 4/5 let

- **Hodnocení** a **kontroly** studia: ~~ŘDS, směrnice děkana~~, ~~kreditní systém~~ (zrušen 2022)

- **Podmínka** přijetí: ukončené mag. VŠ vzdělání, znalost AJ

- **Stipendium**: min. 15 000 Kč, často i podstatně více (grantové projekty, vědecké výstupy)

- **Zahájení studia**: 1. února / 1. září

- **Přihlášky do: 30. dubna / 31. října**

  https://fel.cvut.cz/cz/vv/doktorandi/studium.html

Doktorské studium - průběh

- Volba **rámcového tématu:**
https://fel.cvut.cz/cz/education/phd/phdtopics

- **Domluva** s potenciálním **školitelem**

- Podání přihlášky, **přijímací řízení**

- Vědecká práce pod vedením školitele dle **individ. studijního plánu (ISP)**
    - prezentace výsledků na mezinár. konferencích, vědeckých časopisech
    - krátkodobé stáže, letní školy, jednání vědeckých konsorcií, ..

- **Studijní etapa**: 2/3 roky, min. **2 odb. předměty** (Scientific Writing, ..), **1 vědecký článek**

- Obhajoba odborné studie, tzv. „minima" (příprava k disert. práci), zkouška AJ

- SDZ (ze zákona), nově bezproblémové sloučení SDZ a „minima"

- Volitelná **pedagogická praxe**

- Povinná **zahraniční zkušenost** (stáž, min. 1 měs., doporuč. 6 měs., ERASMUS+)

- Obhajoba disertační práce, **3 vědecké články**, min. **1 IF** nebo konf. příspěvek **CORE A*/A**

- Cena děkana za prestižní disertační práci ☺

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Doktorské studium - studijní programy

- Akustika (spolu s FSv, FS)
- Aplikovaná fyzika
- Bioinženýrství
- Elektrotechnika a komunikace (4 spec.)
- Ekonomika energetiky a elektrotechniky
- Historie věd a techniky
- Informatika (3 spec.)
- Kybernetika a robotika
- Letecká a kosmická technika
- Matematické inženýrství
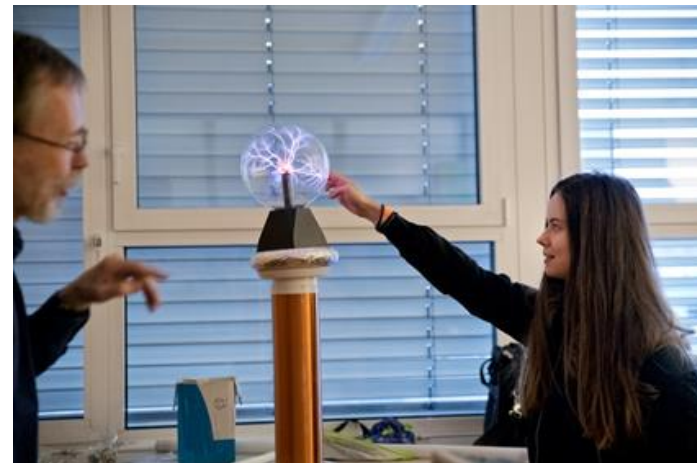
Doktorandi & školitelé (2021)

Celkem: **329** (~ 10 % všech studentů FEL)

Absolventů: **38**

Přijato (z FEE, mimo FEL\v tom zahr.): **100** (54, 46\34)

Školitelů (prof, doc + schválení VR FEL): **213**

~ 1,5 doktorandů/školitele

Medailonky PhD absolventů

Medailonky úspěšných absolventů

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?

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

Mgr. Hynek Bakštein, 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.

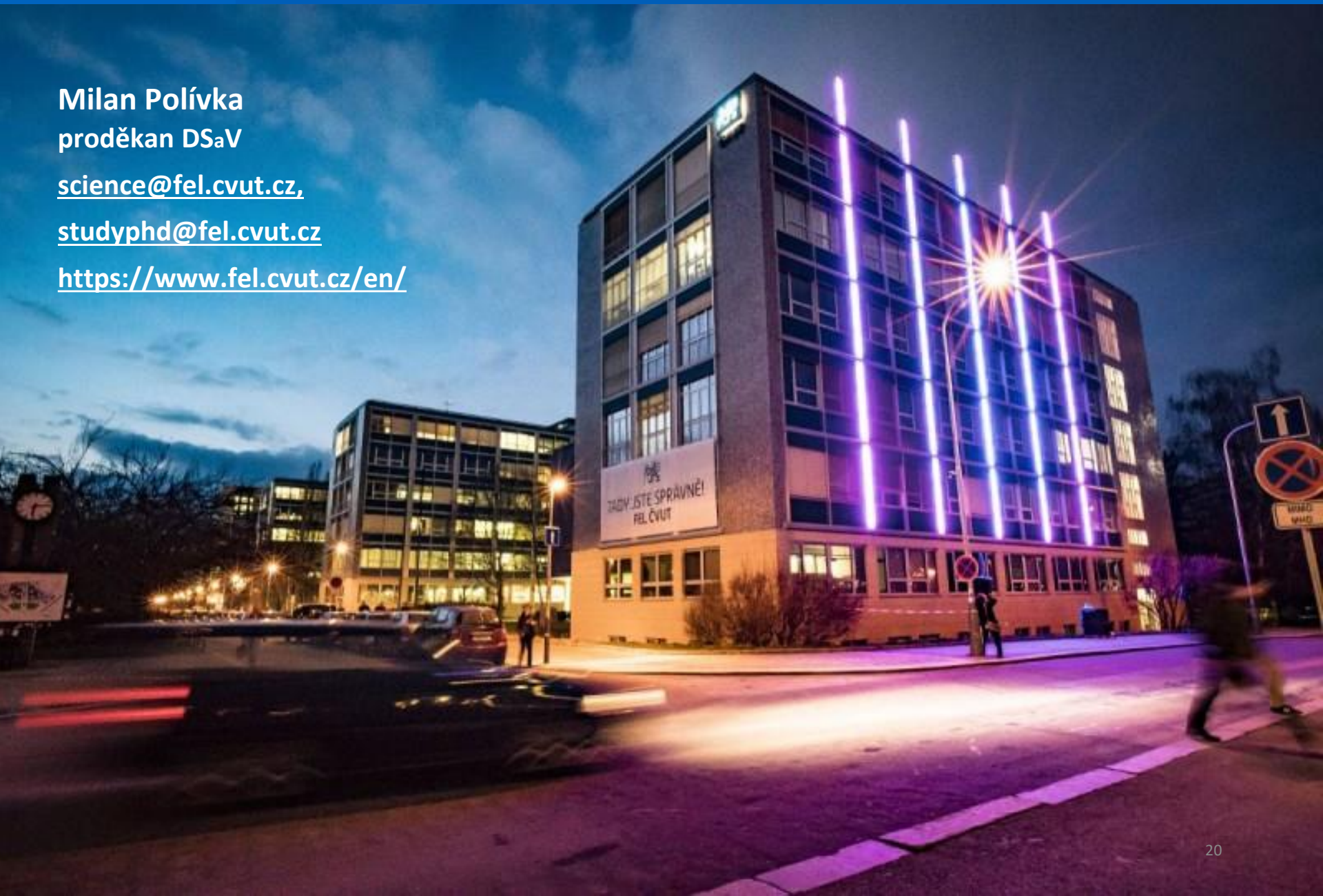3. **Where have you been during your doctoral studies and where have you been at postdoc?**

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

Milan Polívka

proděkan DSaV

science@fel.cvut.cz,

studyphd@fel.cvut.cz

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

Výběr z nejlepších R&D výsledků a úspěchů

Příloha

From Ground to Space

Dept. of Radioelectronics, O. Nentvich[1], M. Urban[2], R. Hudec
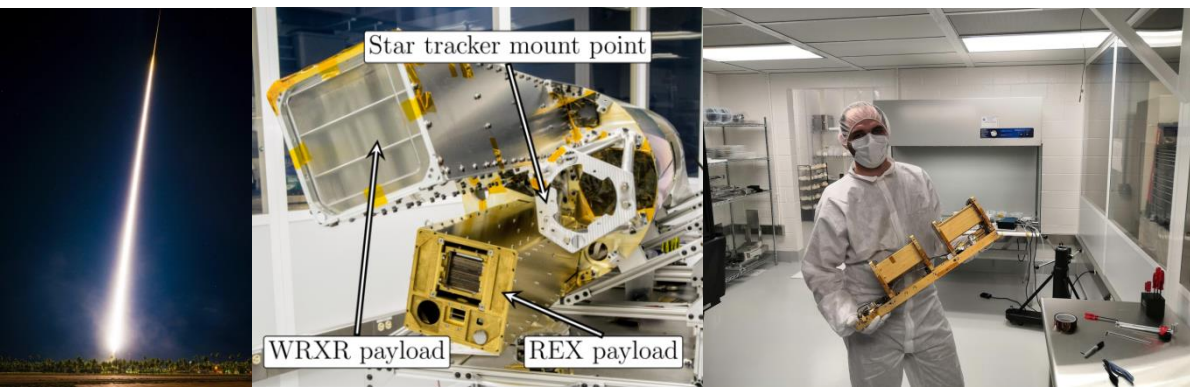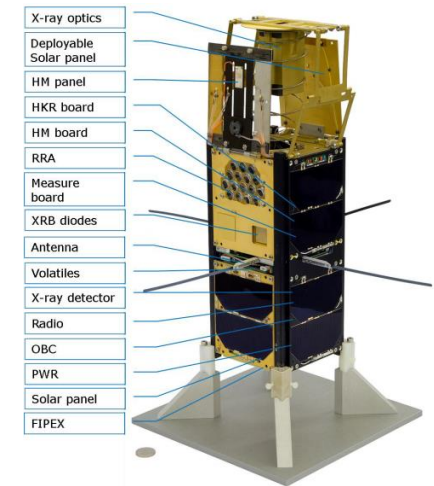
Nanosatellite VZLUSAT-1

- **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)

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

X-ray optics
Deployable Solar panel
HM panel
HKR board
HM board
RRA
Measure board
XRB diodes
Antenna
Volatiles
X-ray detector
Radio
OBC
PWR
Solar panel
FIPEX

Star tracker mount point

WRXR payload   REX payload

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

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/
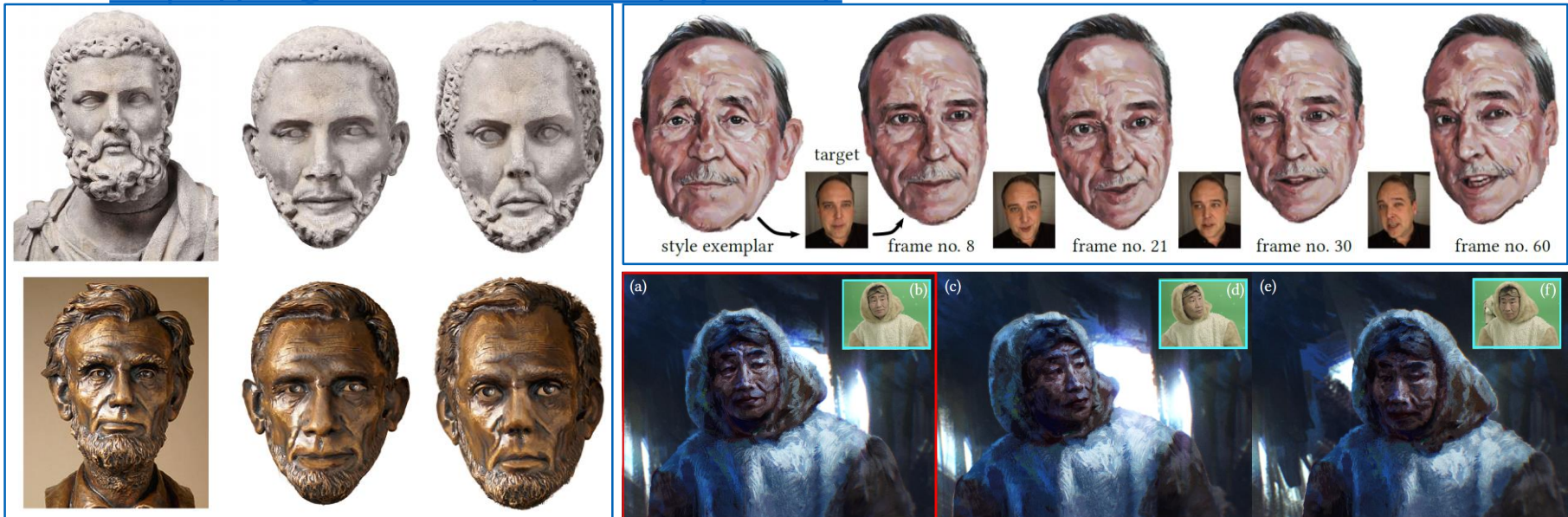
Smooth Analysis in Banach Spaces
Petr Hajek, Dept. of Mathematics

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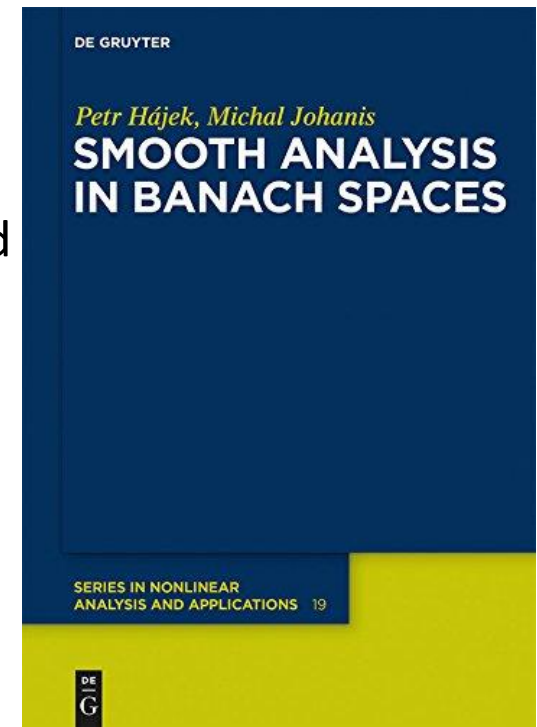
High-yield fabrication and properties of 1.4 nm nanodiamonds with narrow size distribution

K13102

https://v3s.cvut.cz/results/detail/305696 [Scientific Reports 6 (2016) 2045]
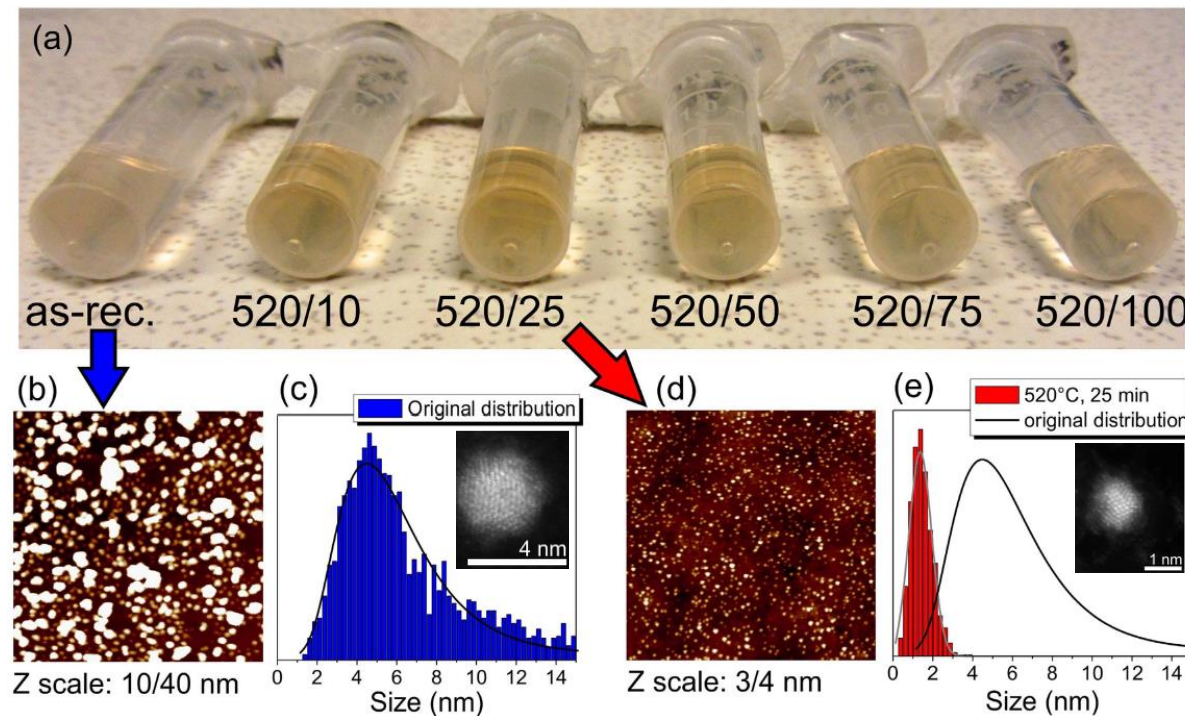
Broad impact of the result:

- 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 <u>controllable</u> size reduction of NDs down to <u>1.4 nm</u> (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).

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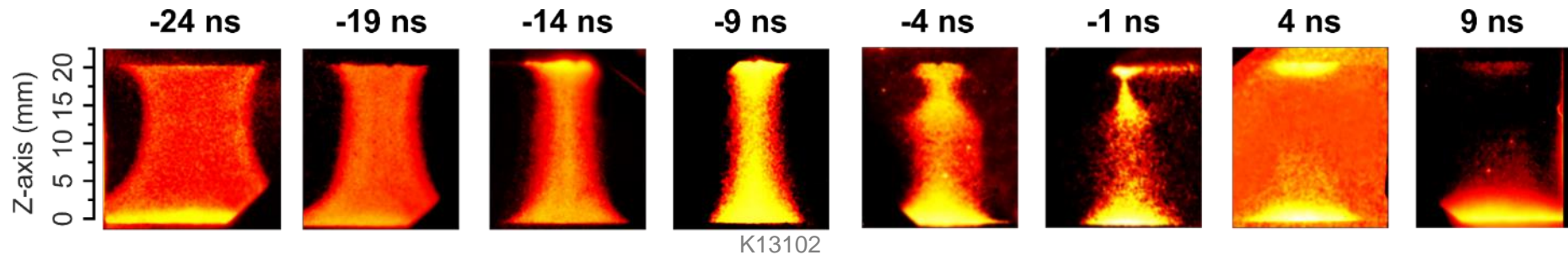
- Fast increase of impedance with a sub-nanosecond *e*-folding time leads to ion acceleration and neutron production in terawatt pulsed-power generator (GIT-12 in Tomsk, Russia)
- Increased neutron yields above 10^{13} at the current of 2.7 MA; deuterons reach 60 MeV
- Significant contribution to <u>solution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

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

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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** (**S**ilicon Carbide **P**ower Technology for **E**nergy **E**fficient **D**evices) supporting innovation in new power electronic technologies for energy applications – development of European silicon carbide power electronics
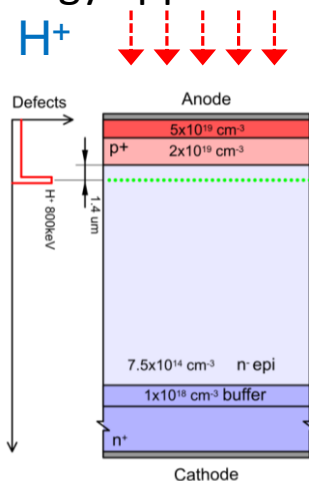
The principle
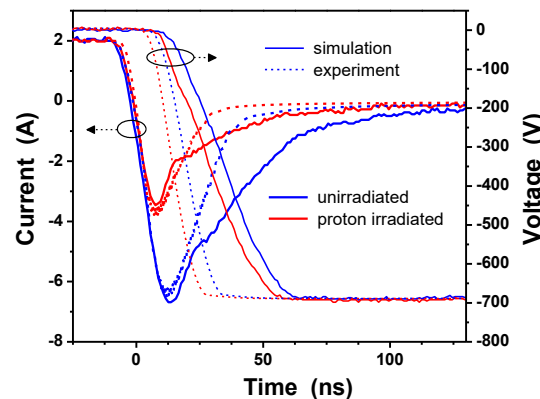
Diode Reverse-Recovery Waveforms
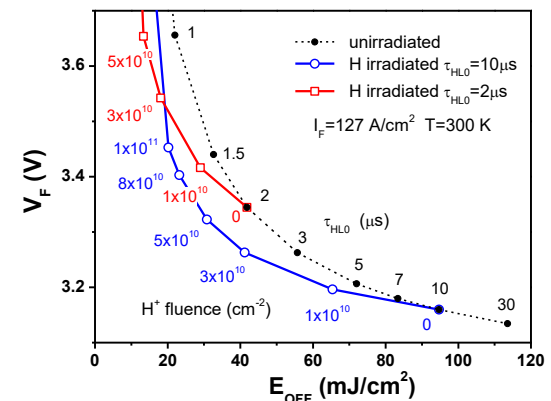
Static/Dynamic Losses Optimization

Spreading spark discharge via mutual action of acoustic and magnetic fields

K13102

scitation.org/journal/jap

Journal of Applied Physics
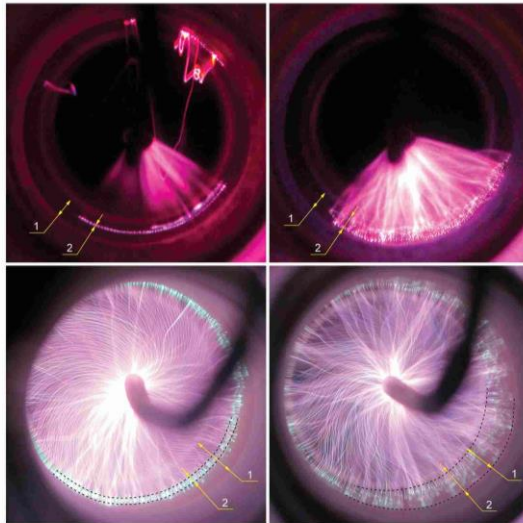
Volume 126, Issue 8, 28 Aug. 2019

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)

Europaisches Patentamt
European Patent Office
Office européen des brevets

https://v3s.cvut.cz/results/detail/332610
https://v3s.cvut.cz/results/detail/315075

29

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

Normalized streaming velocity, $\text{Re}_{nl} = 1$

J. Acoust. Soc. Am. 2017 & 2018
https://v3s.cvut.cz/results/detail/312111
https://v3s.cvut.cz/results/detail/319375
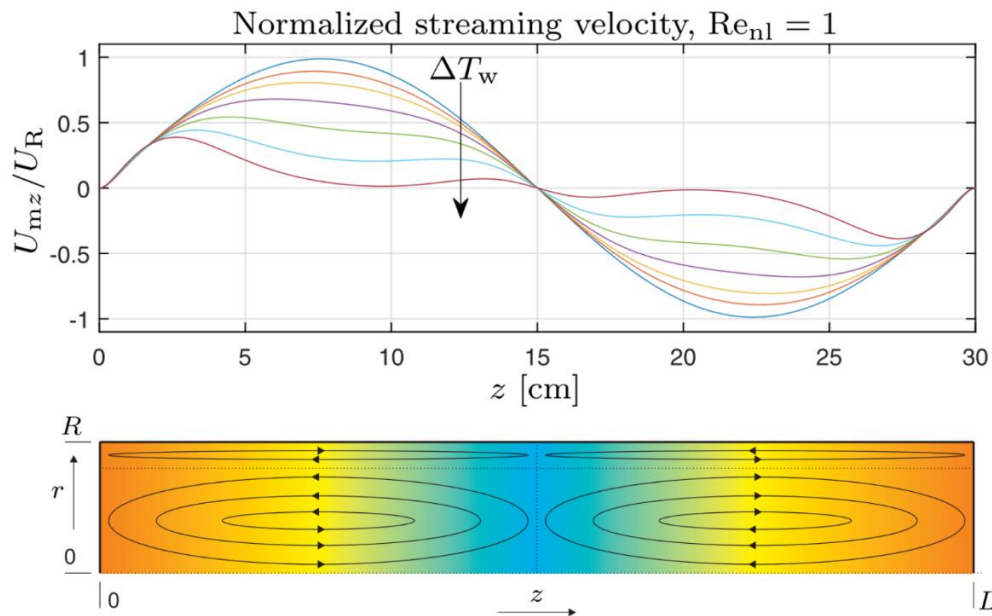
- **Acoustic streaming** = net mean fluid flow that is generated by and superimposed on acoustic field

- **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

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.

E.Coli bacterium and H-nanodiamonds

E.Coli bacterium and graphene oxide
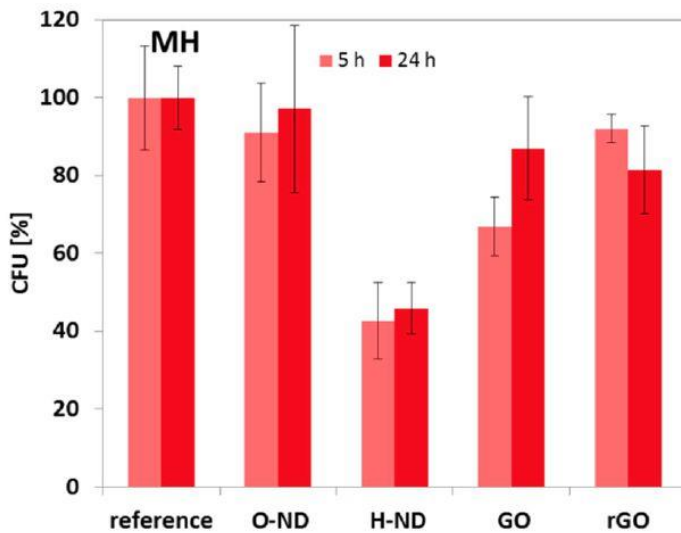
O-ND / H-ND - oxidized / hydrogenated 5 nm nanodiamonds
GO – graphene oxide, rGO – reduced graphene oxide flakes
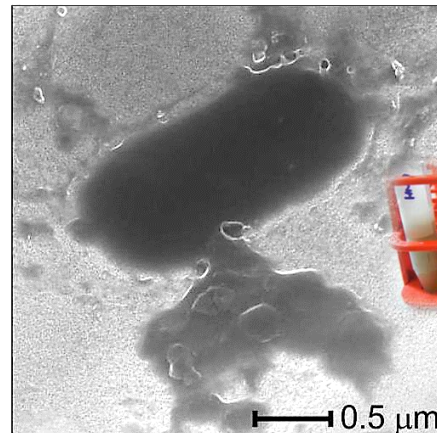
Bacterium is damaged by H-NDs, cytoplasm is leaking.
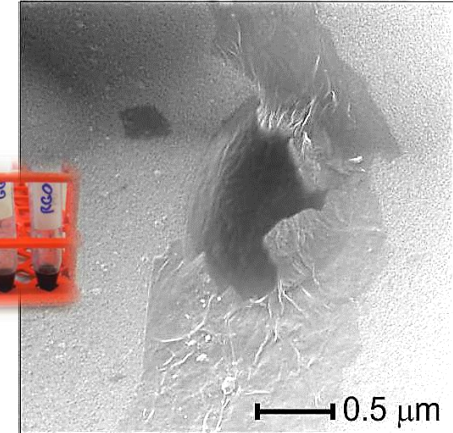
Bacterium is wrapped by GO sheets and gradually perishes.

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
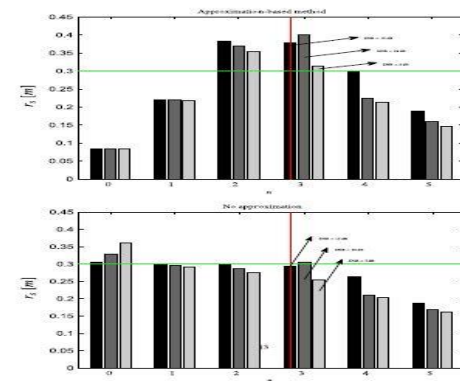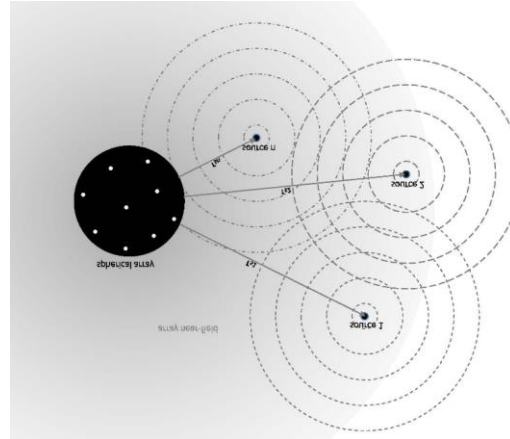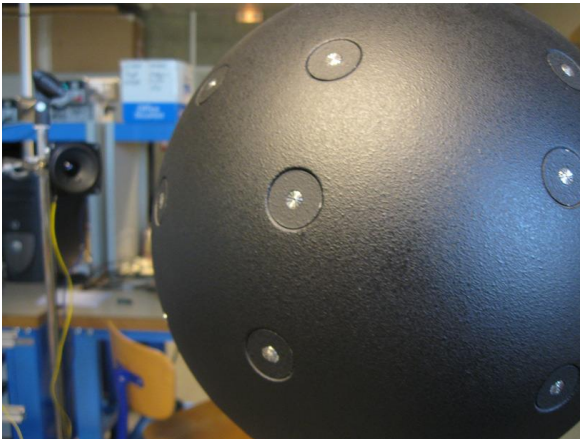
Electrical discharges for energy efficient generation of active molecular species

K13102 + K13116
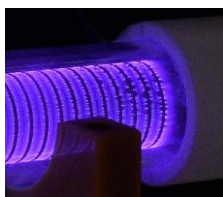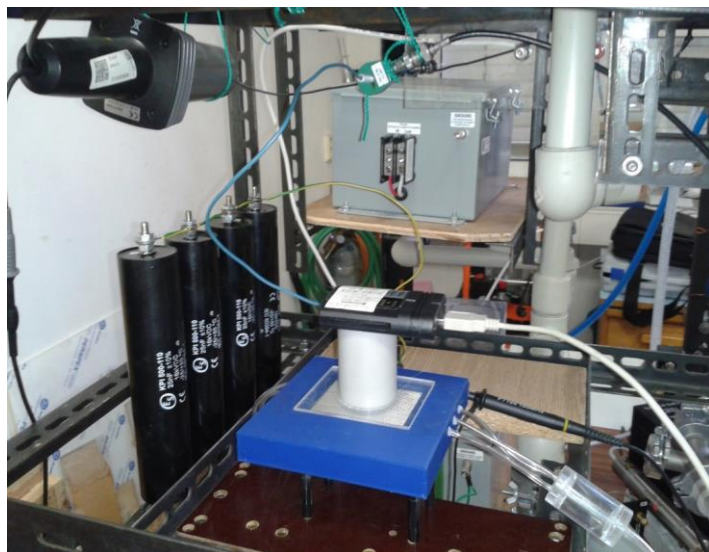
- Attention is focused on corona, and dielectric barrier discharges for the **generation of ozone and nitrogen oxides to kill bacteria, viruses (Covid-19) and for wound healing**.
- **Increased generation efficiency** of these species: usage of non-traditional materials, energization, optimization of 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.

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 identity 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.
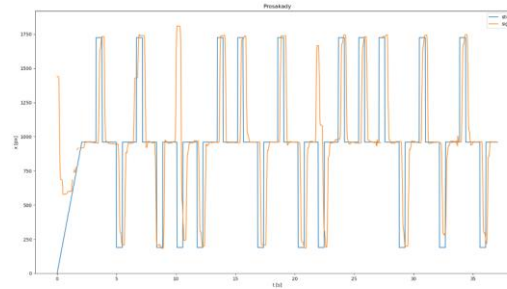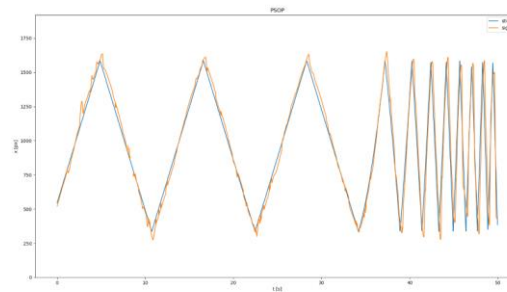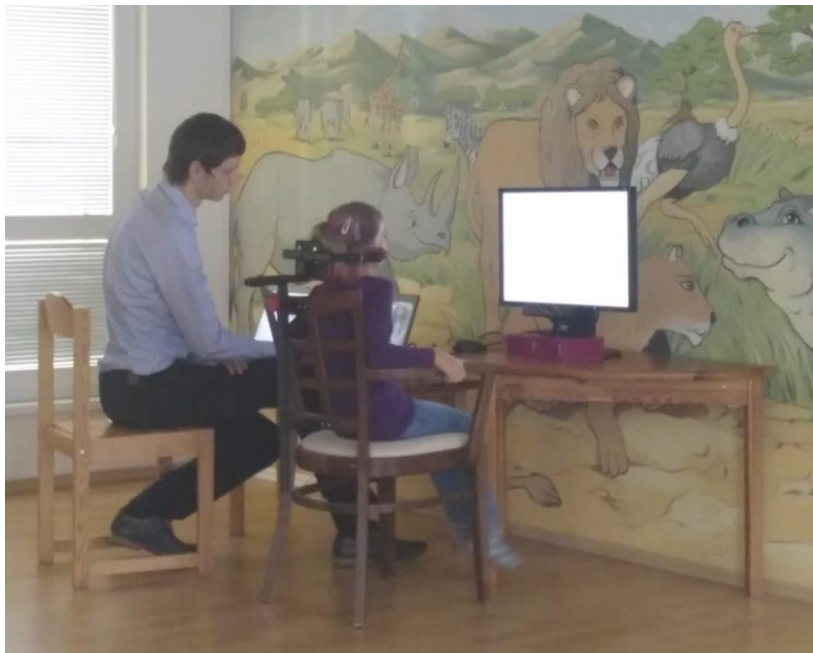
Virtual reality and eye-tracking for testing competencies in HR
M. Dobiáš, Department of economics, management and humanities

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.
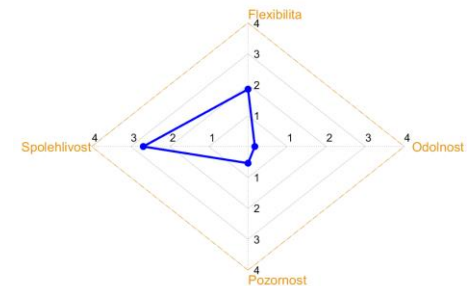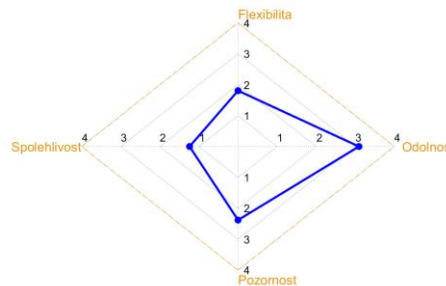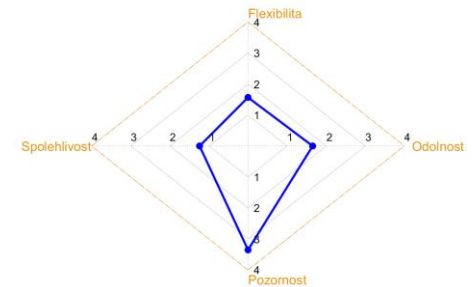
Microwave Ablation: Device Development and Treatment Planning

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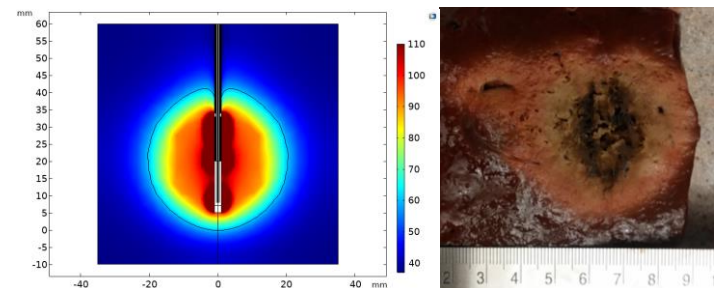
Our second goal is to develop the patient-specific probabilistic treatment planning framework for guiding treatment parameters like applicator position, and energy dose to mitigate current challenges like local tumor recurrence.

Sebek et al. Medical Physics 2016; 43.5: 2649-2661,

Sebek et al. Medical Physics 2019; 46.10: 4291-4303.

Applicator

Tumor

100% probability of ablation

0 % probability of ablation
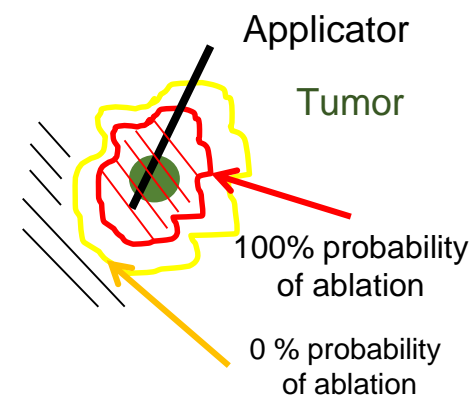
Forecasting of epileptic seizures

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:
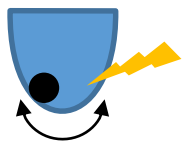
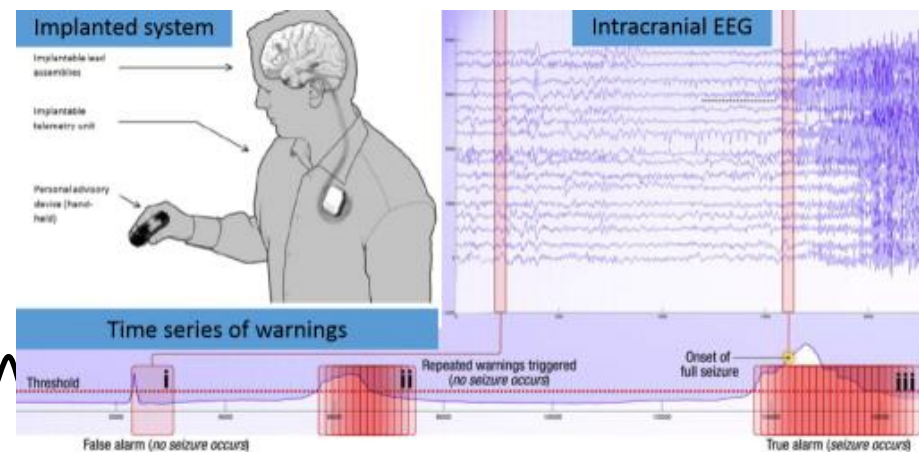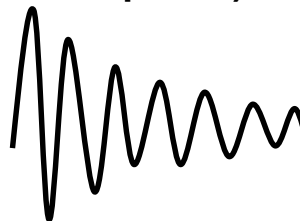potential valley   perturbation

Unstable system:
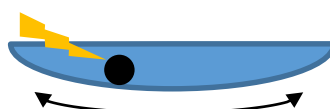
Oscilattion around equlibrium (impuls responce)

fast oscilation
low amplitude
fast damping

slow oscilation
high amplitude
slow damping

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

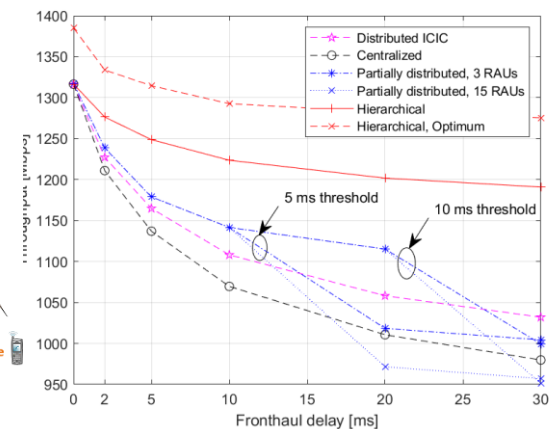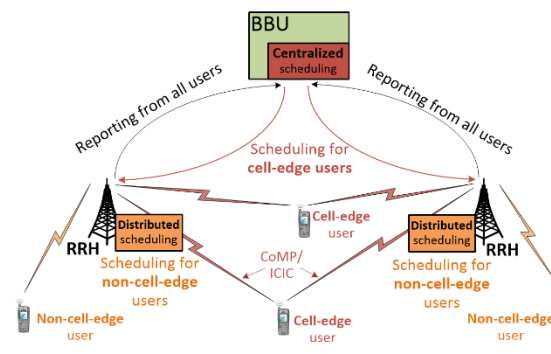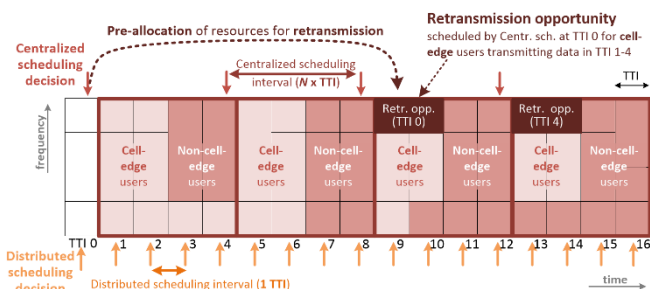## Z. Becvar, Department of Telecommunication Engineering

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

Z. Becvar, P. Mach, "Methods and devices for resource scheduling in wireless communication systems", *US patent no*. US10798722B2, October 2020.

Z. Becvar, P. Mach, M. Høgdal, A. Popovska-Avramova "Hierarchical resource scheduling method of wireless communication system", *US patent no*. US10624105B2, April 2020.

Prediction of direct channel among devices (D2D communication)
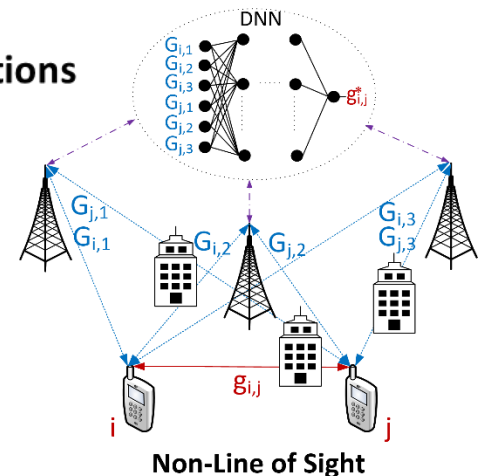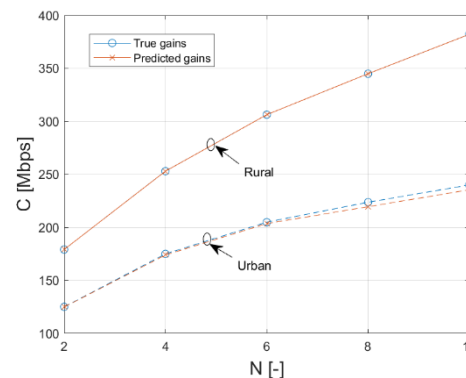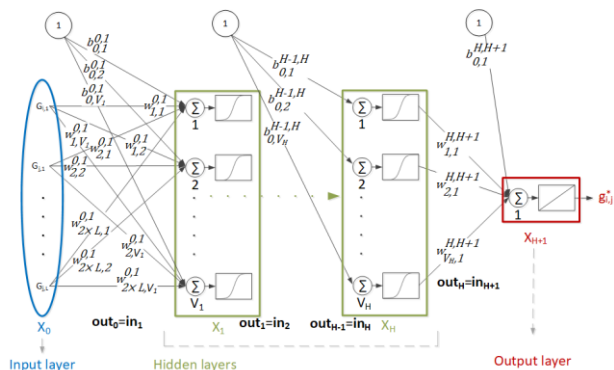## Z. Becvar, Department of Telecommunication Engineering

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

Non-Line of Sight

Direct communication of (almost) any number of devices enabled

M. Najla, Z. Becvar, P. Mach, D. Gesbert, "System and Method for Device-to-device Communication ", *US patent* filled in June 2020.
M. Najla, P. Mach, Z. Becvar, and D. Gesbert, "Predicting D2D Channels from Cellular Channel Measurements: A Learning Approach," *IEEE Transactions on Wireless Communications, June 2020*
M. Najla, D. Gesbert, Z. Becvar, P. Mach, "Machine Learning for Power Control in D2D Communication based on Cellular Channel Gains", *IEEE Globecom 2019* workshop.

# DARPA SubTerranean 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 …
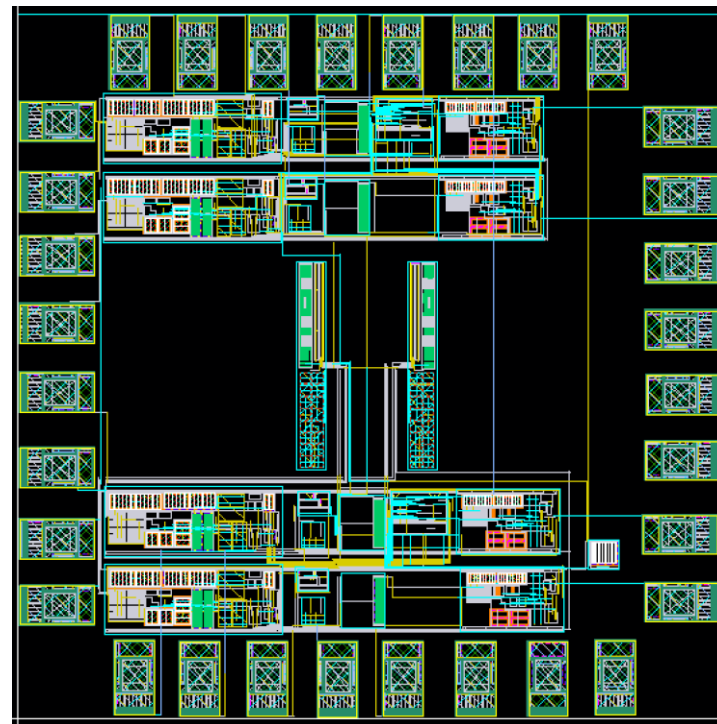http://robotics.fel.cvut.cz/cras/darpa-subt/
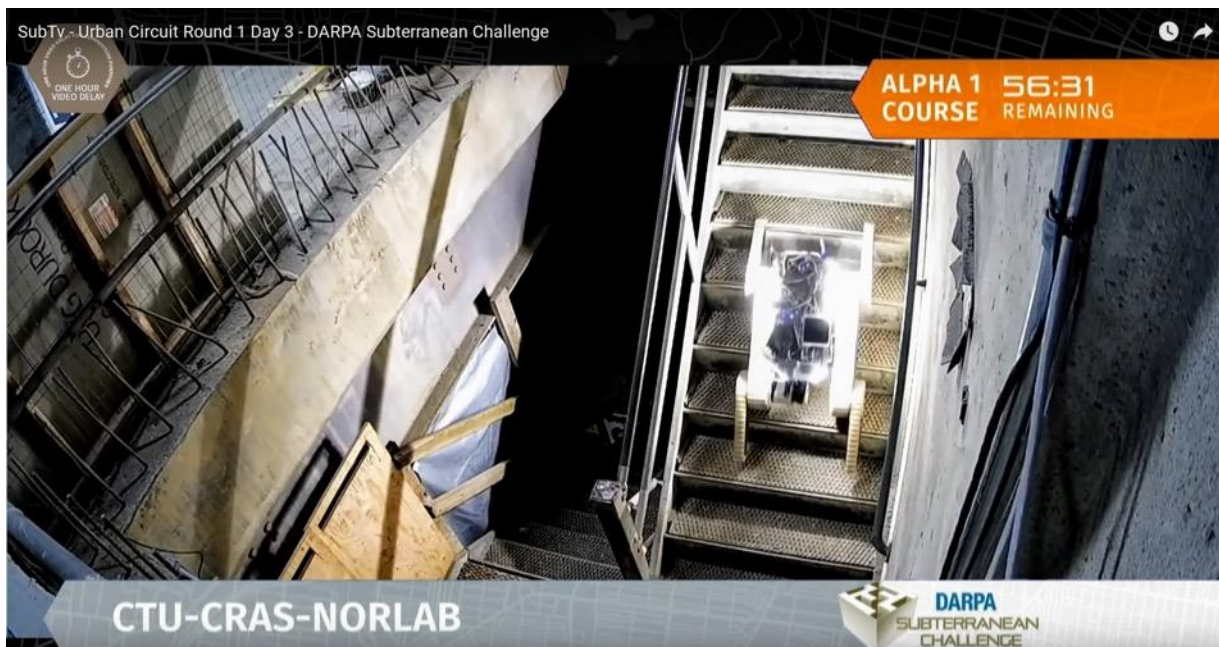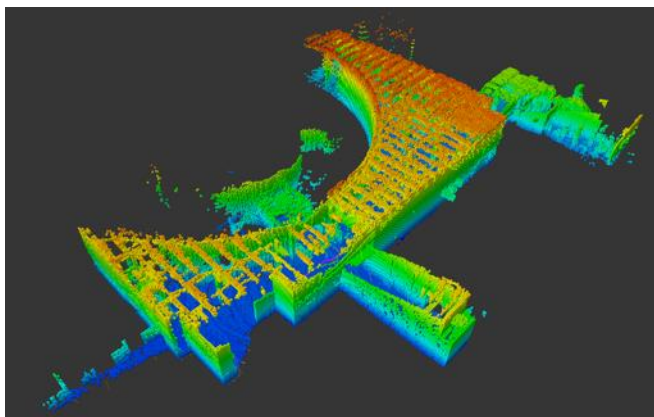
MEMS sensors with optical scanning
Microsystems Group (Janíček, Husák), Department of Microelectronics

- Within the ESO MEMS project CTU developed a layout of data processing circuit for MEMS system wit optical scanning.

- It uses a X-Fab 180 nm technology.

- The result will be applied at Honeywell, Inc.
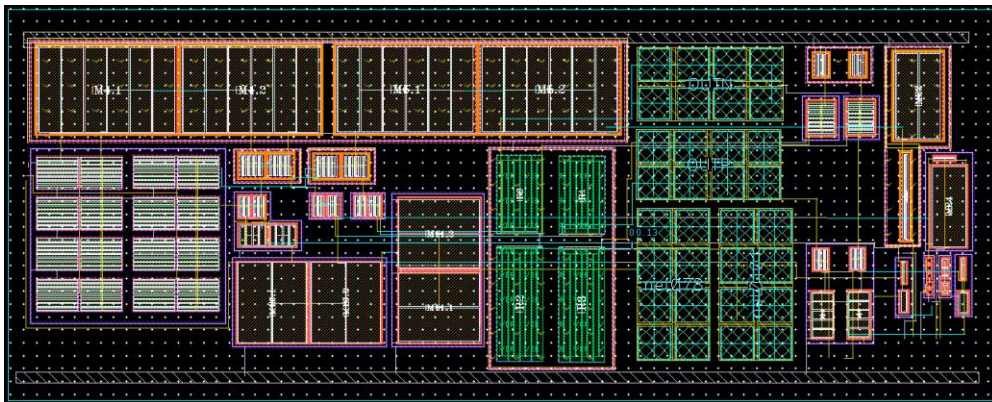

Partial layout

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 .
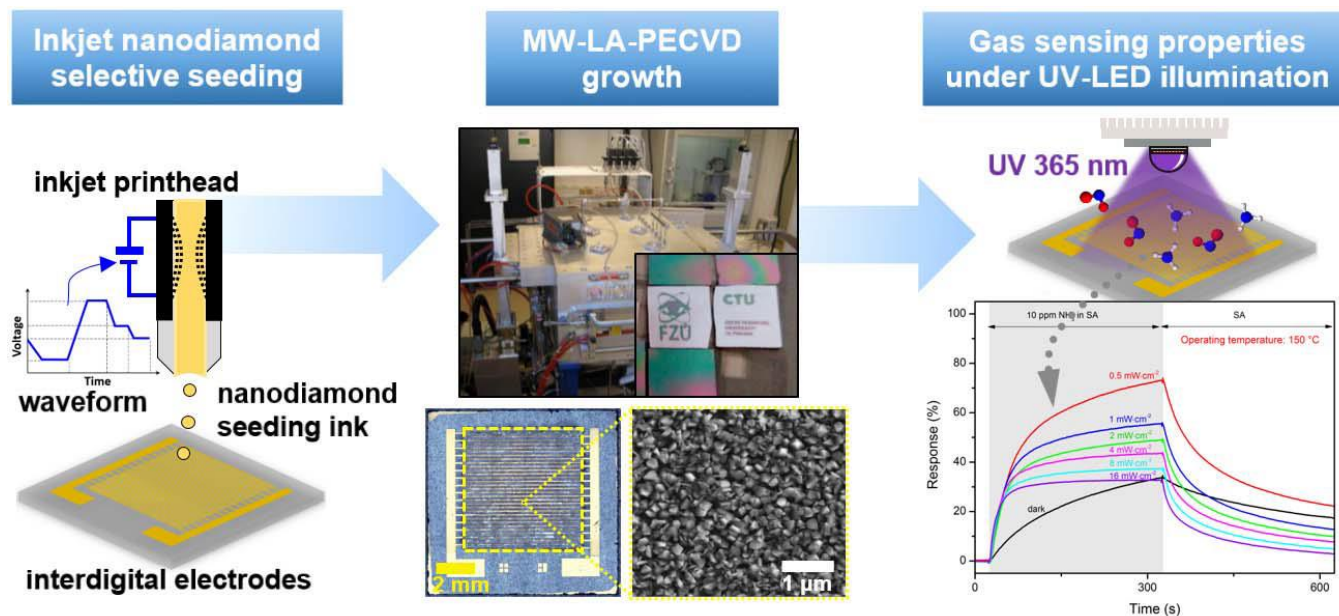
Large Core Optical Planar Splitters
Opto Electronics Group, Václav Prajzler, Department of Microelectronics

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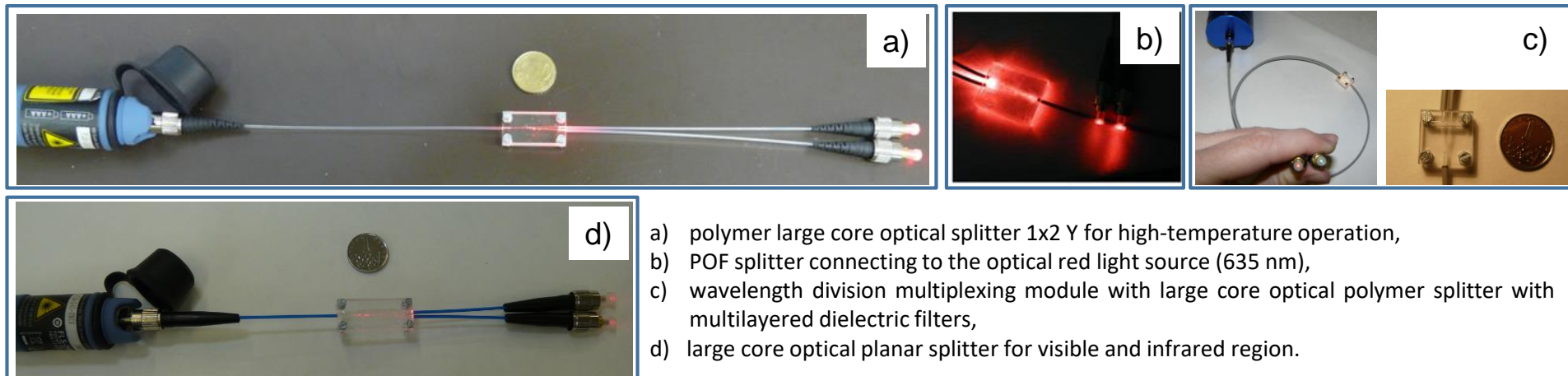
a) polymer large core optical splitter 1x2 Y for high-temperature operation,
b) POF splitter connecting to the optical red light source (635 nm),
c) wavelength division multiplexing module with large core optical polymer splitter with multilayered dielectric filters,
d) large core optical planar splitter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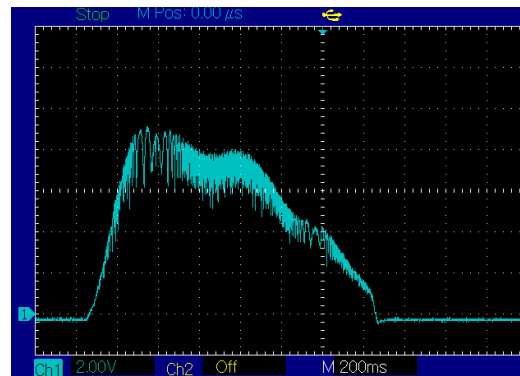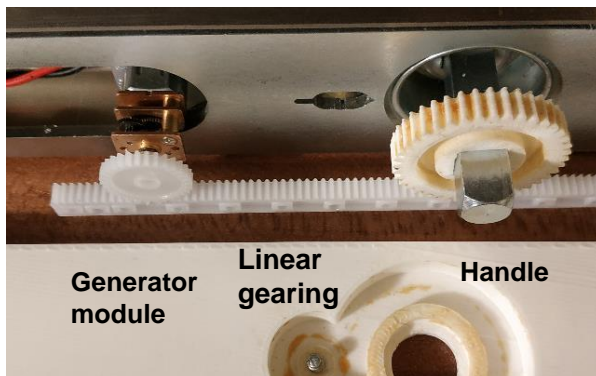

Waveform of generated voltage: 2V/div., 200 ms/div.

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 6×10 mm^2 on PCB and price of the components is 30 times lower then 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.
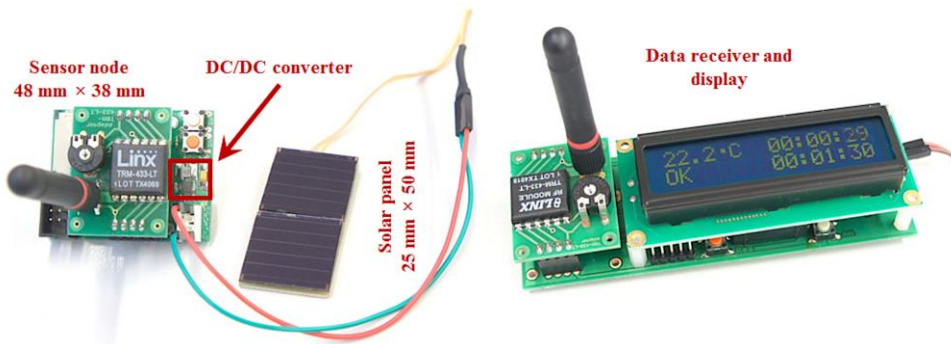
Developed sensor node with energy harvesting circuit and the receiver.
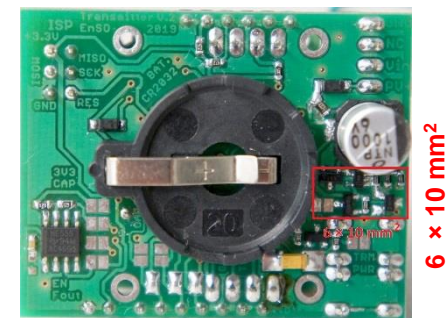
Energy harvester on sensor node PCB

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
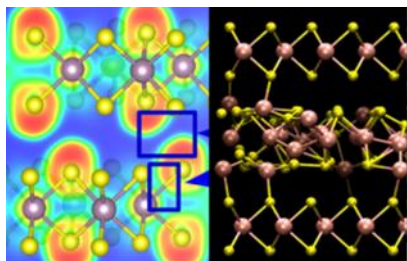## Dept. of Control Engineering - Tomáš Polcar group

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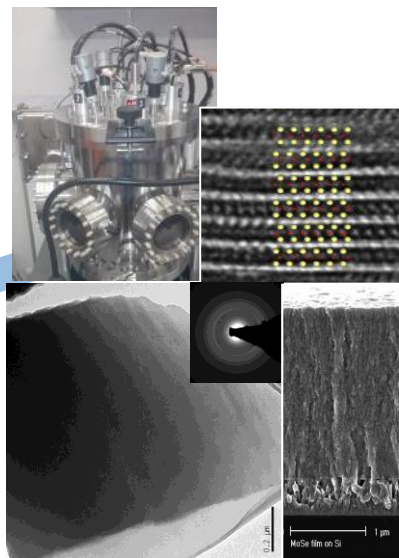ACS Appl Mat Int 2019
Nanoscale 2018

Material Fabrication
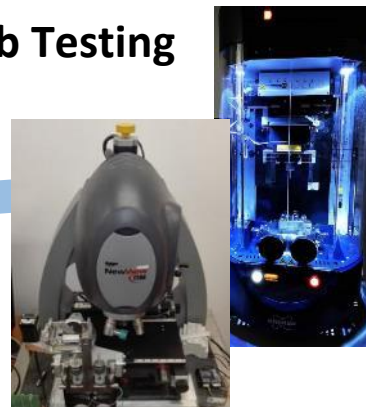
Lab Testing

Atomistic simulations

Process Up-scale

Deposition on real part

Application: solid lubricant on actuator for L39 NG

Industrial testing

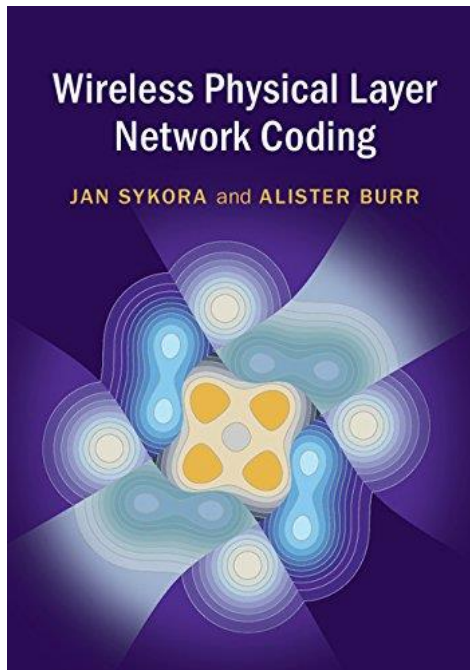**Advanced Materials Group**
nano.cvut.cz

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/√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
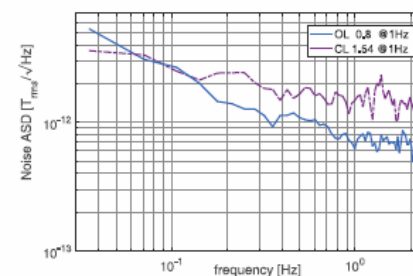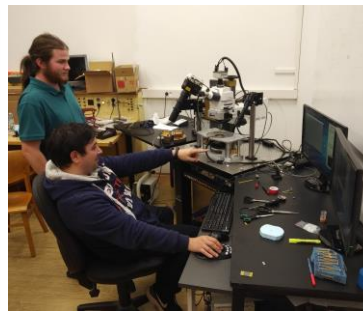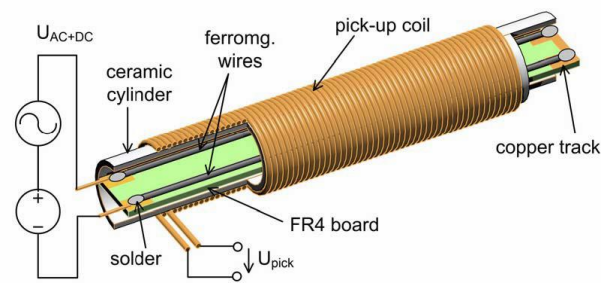
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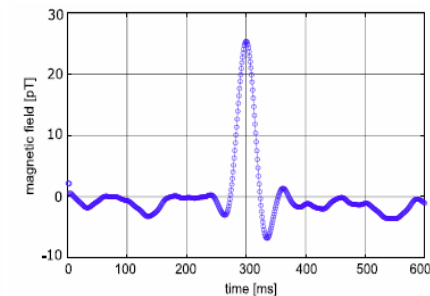
# Multimedia transmission quality subjective testing with parallel task
Jan Holub, Hakob Avetisyan, Dept. of Measurement

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 paralell task world-wide.

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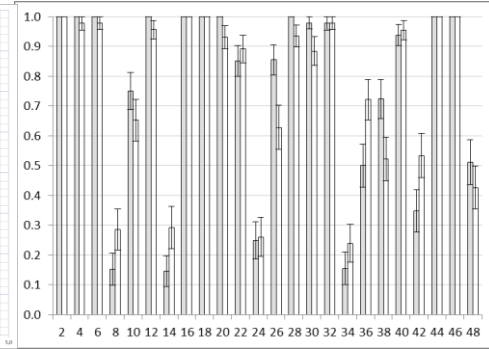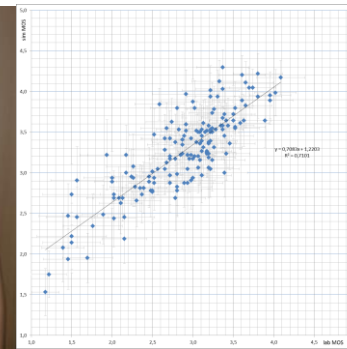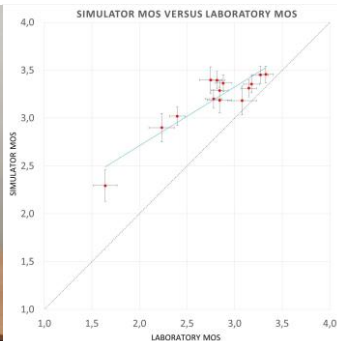
Lightdrum: A portable device for texture measurement (BTF, BRDF)
prof. V. Havran – Dept. of Comp. Graph. & Interaction (DCGI)

- 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/

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