MOTTO: TRANSFORMING THE REALITY

Faculty of Mechanical Engineering
Czech Technical University in Prague

Miroslav Španiel
Dean of the Faculty

FACULTY OF MECHANICAL ENGINEERING CTU IN PRAGUE

History of FME CTU

- FME founded 1864
- FEE separated from FME in 1950
- FME helped to establish Faculty of Mechanical Engineering in Pilsen, Liberec, Zilina and Kosice
- Long tradition, 2024 we have celebrated 160 years of the FME

FACULTY OF MECHANICAL ENGINEERING CTU IN PRAGUE

Mission and vision of FME CTU

The mission of FME CTU is:

- to develop new knowledge, to expand it, and to preserve the expertise gained in engineering disciplines, especially in the field of mechanical engineering
- enable access and carry out higher mechanical engineering education
- contribute to the development of the economy and life quality in the Czech Republic
- play an active role in the public debate on social and ethical issues of technology
- sustain and develop international cooperation.

FACULTY OF MECHANICAL ENGINEERING CTU IN PRAGUE

Mission and vision of FME CTU

The vision of FME CTU is to sustain and improve the position of FME

FME CTU:

- is an international center of excellence in the fields of engineering and industrial sciences, creative activity and education.
- attracts the best students from the Czech Republic and gifted students from abroad to study at FME
- brings stimuli for new basic&applied research, these research results are applied in practice for the development of the economy and life quality in the Czech Republic

FACULTY OF MECHANICAL ENGINEERING CTU IN PRAGUE

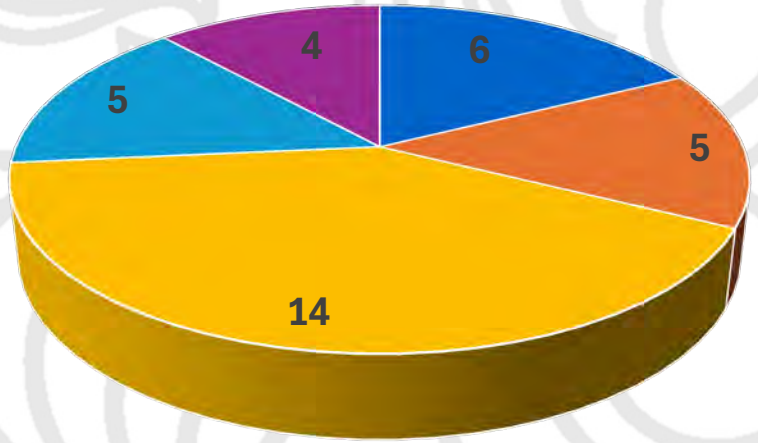
Faculty as an academic institution and as a company

Areas	Academic institution view	Company view
Teaching	Education	Student income
Research	Science, research	Grants from funding agencies
Contracts	Know-how transfer	Contracts with companies
Patents, spin-off	Support for the economy	Sales, business
Knowledge	Knowledge preservation, service to society	Sales to the public
Attracting & providing people	Social function	Student acquisition, graduate supply
Entertainment, cohesion of society	Social function, service to society	Gifts and transfers to the public

FACULTY OF MECHANICAL ENGINEERING CTU IN PRAGUE

Data about FME

- **Academic staff 358**
  - Professors 43 – 4% from abroad
  - Associate professors 62
- **Students 1639 (Ph.D. 205) – 10% from abroad**
  - Incomming 2023-4/2024-5: **697/828** (Bc. **440/521**, Master **190/255**, Ph.D. **67/52**)
  - Graduated 2023-4: **496** (Bc. **224**, Master **232**, Ph.D. **40**)
- **Turnover 34 mil Eur, 2024**
  - Teaching 6 mil Eur
  - Institutional support for research 5 mil Eur
  - Projects 14 mil Eur
  - Contracts 5 mil Eur
  - Others (scholarships etc.) 4 mil Eur



FACULTY OF MECHANICAL ENGINEERING CTU IN PRAGUE

Data about FME

FME departments

- Department of Technical Mathematics
- Department of Physics
- Department of Mechanics, Biomechanics and Mechatronics
- Department of Fluid Dynamics and Thermodynamics
- Department of Designing and Machine Components
- Department of Materials Engineering
- Department of Manufacturing Technology
- Department of Machining, Process Planning and Metrology
- Department of Instrumentation and Control Engineering
- Department of Production Machines and Equipment
- Department of Energy Engineering
- Department of Automobiles, Combustion Engines and Rail Vehicles
- Department of Aerospace Engineering
- Department of Environmental Engineering
- Department of Process Engineering
- Department of Management and Economics
- Department of Foreign Languages

FME research centers

- Vehicle Center of Sustainable Mobility
- Innovation Centre for Diagnostic and Application of Materials
- Center of Aviation and Space Research

FACULTY OF MECHANICAL ENGINEERING CTU IN PRAGUE

Data about FME

- **Bachelor study programme**
  - Mechanical engineering, Sustainable Mobility - Powertrains and Vehicles
- **Master study programmes**
  - Applied sciences in mechanical engineering (Applied mechanics, Mechatronics, Mathematical modelling, Biomechanics)
  - Automation and instrumentation technology
  - Transportation and handling technology
  - Master of Automotive Engineering
  - Aeronautics and Astronautics
  - Robotics and production machines
  - Energy and process engineering
  - Nuclear power engineering equipment
  - Intelligent buildings
  - Environmental technology
  - Production engineering
  - Management of industrial processes
- **Study programmes with other faculties**
  - Scenic technologies
  - Design
  - Teaching of mechanical engineering subjects for secondary schools
  - Quantum informatics

FACULTY OF MECHANICAL ENGINEERING CTU IN PRAGUE

Data about FME

- **Top 10 fulltime professors and associate Professors**

Full Professor	index	Papers	Citations	Years	Teaching
Vyhlídal Tomáš prof. Ing. Ph.D.	15	53	702	26	16
Vojtíšek Michal prof. M.S., Ph.D.	15	40	625	27	7
Špatenka Petr prof. RNDr. CSc.	15	43	1060	48	4
Daniel Matej prof. RNDr. Ph.D.	13	50	502	22	10
Valášek Michael prof. Ing. DrSc.	11	55	362	46	20
Žitný Rudolf prof. Ing. CSc.	10	38	226	56	1
Jirout Tomáš prof. Ing. Ph.D.	9	68	437	25	25
Rieger František prof. Ing. DrSc.	8	47	222	60	1
Šika Zbyněk prof. Ing. Ph.D.	8	32	224	33	25
Kolovratník Michal prof. Ing. CSc.	7	16	175	40	16

Associate Professor	Hindex	Papers	Citations	Years	Teaching
Vacek Václav doc. Ing. CSc.	75	1326	35041	50	0.5
Sedláček Radek doc. Ing. Ph.D.	14	37	415	26	3
Suchý Tomáš doc. Ing. Ph.D.	13	47	517	22	1
Horný Lukáš doc. Ing. Ph.D.	11	35	292	20	5
Cvrček Ladislav doc. Ing. Ph.D.	11	31	357	25	6
Španiel Miroslav doc. Ing. CSc.	10	19	207	35	12
Matuška Tomáš doc. Ing. Ph.D.	9	22	314	25	10
Entler Slavomír doc. Ing. Ph.D.	9	52	319	35	3
Zeman Pavel doc. Ing. Ph.D.	9	22	230	22	5
Krátký Lukáš doc. Ing. Ph.D.	8	23	372	14	11

FACULTY OF MECHANICAL ENGINEERING CTU IN PRAGUE

SWOT analysis

Strengths

- Knowledge and topics for almost all areas of ME
- Links to industry, including foreign ones
- Relevance for industry and society as a whole
- Existing ecosystems and know-how to build them
- CC, NCC, we are growing in participation in HORIZON projects
- How to make research contracts, results, how to organize cooperation

Opportunities

- Present Mechanical Engineering as connected with attractive topics like ecology, AI, … and possibility of application of knowledge
- The breadth of applications and the needs of industry and society and possibility to define goals and directions of industry
- Existing ecosystems and know-how to do them
- CC, NCC, EU Horizon project calls
- Innovation for industry, completing TRL 5-6 and industrial implementation of R&D results interdisciplinary

Weaknesses

- We have difficulty to generalize cooperation with industry into basic research topics despite we are trying to do it.
- We do not produce enough publications despite we have many topics (we improved but sill not enough)
- We do not have enough research (GACR, ERC, EC, …) grants
- We do not have enough international contacts, cooperation, stays
- We still have shortcomings in the treatment of intellectual property, although we have improved.

Threats

- Mechanical engineering is perceived as outdated, difficult, non-ecological – resulting to lack of students
- Lack of people qualified to guarantee the study programs and key subjects
- The most popular topics of research (AI, quantum, semiconductors, circular economy …) are perceived out of ME despite it is interconnected.
- General threats to EU/CR researchand industrial funds are also considered as threats to the FME

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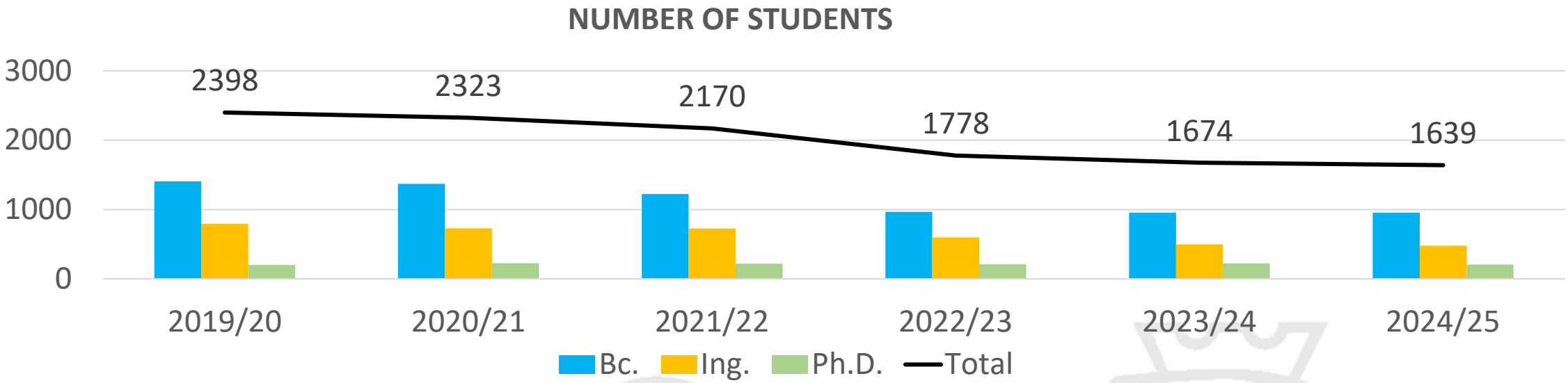
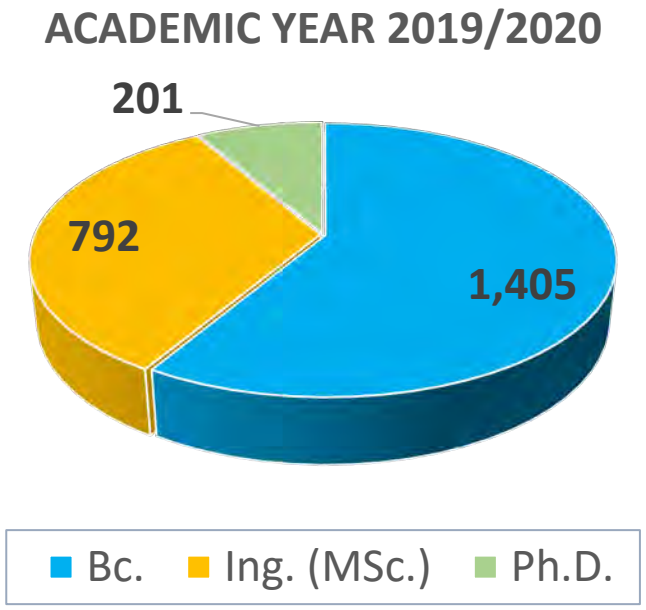
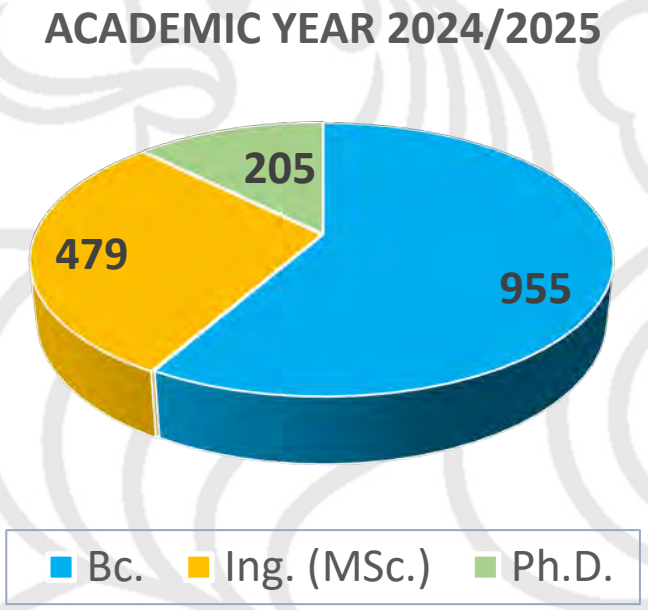
FACULTY OF MECHANICAL ENGINEERING CTU IN PRAGUE

Development of students at FME







FACULTY OF MECHANICAL ENGINEERING CTU IN PRAGUE

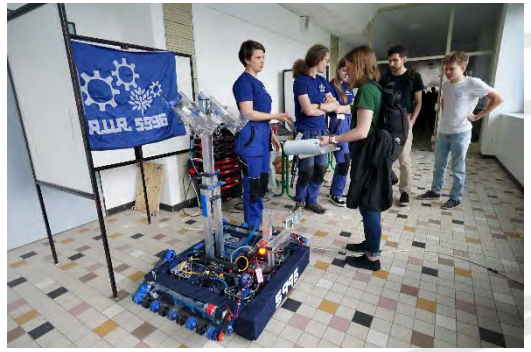
Recruiting new students

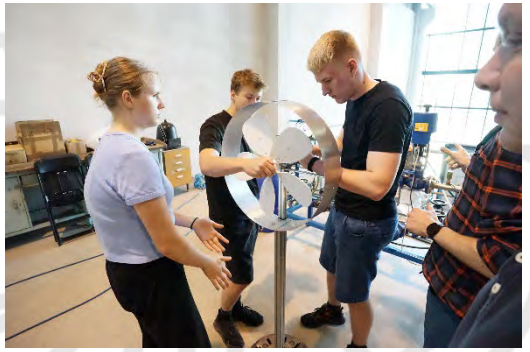
Quantum informatics

We have expanded our bachelor's degree program with a new program - Sustainable Mobility in cooperation with the University of Technology and Chemistry

For applicants to the Bachelor's program in Mechanical Engineering, we have introduced the possibility to express their preferences by choosing a profile. The profiles simultaneously demonstrate the broad scope, attractiveness, and social relevance of mechanical engineering.

We organize open days for the public and other events for potential applicants for study.





FACULTY OF MECHANICAL ENGINEERING CTU IN PRAGUE

Activity of students and for students

- Formula Student (eForce Prague Formula)
- CTU AeroLab
- CTU Space Research
- CTU Robotics
- Cenelin
- ESC (Engineering Student Club)

FACULTY OF MECHANICAL ENGINEERING CTU IN PRAGUE

Activity of students and for students

- **Zvonicek Foundation** –rewarding the best diploma theses

- **CVUT Media Lab foundation**
  supports students in developing innovative ideas development
- **CVUT Tech, ltd.** – creation of spin-offs and transfer of technologies, FME was one of founders and has been involved in supervisory board

FACULTY OF MECHANICAL ENGINEERING CTU IN PRAGUE

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FACULTY OF MECHANICAL ENGINEERING CTU IN PRAGUE

Measures to increase publications

- Motivation to produce impact publications as results of applied research with industry
- Direct rewarding of publications
- Projects to support publishing have been implemented
- Increasing our activity in accepting postdocs by participating in the CTU Future Fund project
- providing new researchers with mentoring for preparation of basic research projects (GAČR …)
- using the existing research base including our ecosystems and involvement in international and interuniversity projects.

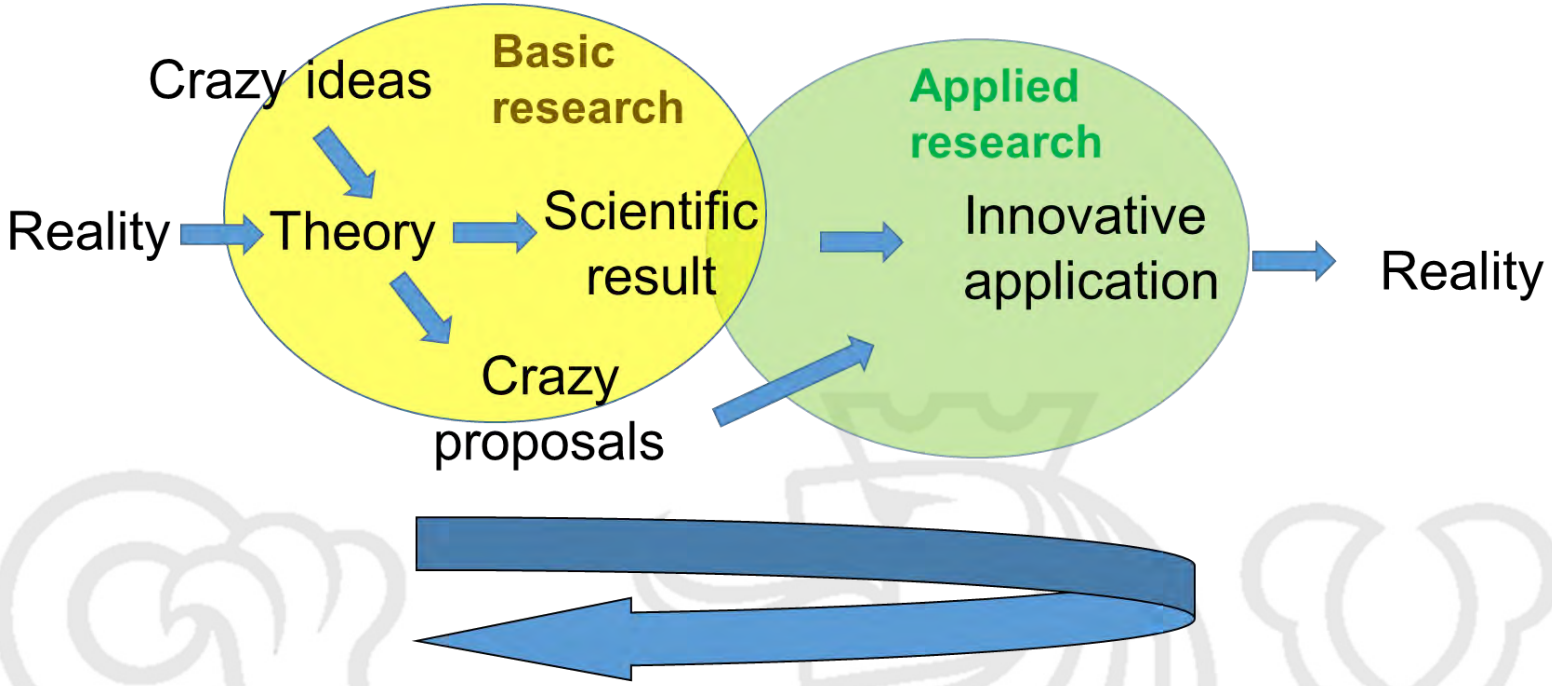
With important **target** to **increase the number of habilitated staff**

FACULTY OF MECHANICAL ENGINEERING CTU IN PRAGUE

Specific responsibility

We have specific responsibilities of technical university

- We feel responsible within our competencies for the competitiveness of industry and thus economy in the Czech Republic in global markets
  - Our contribution is to prepare enough graduates
  - Offer knowledge with innovation potential for industry (ecosystems)



- **We are constantly making decisions how much resources devote to basic and how much to applied research and development**

These two questions are being continuously discussed and balanced.

Faculty has to deal with specific decisions

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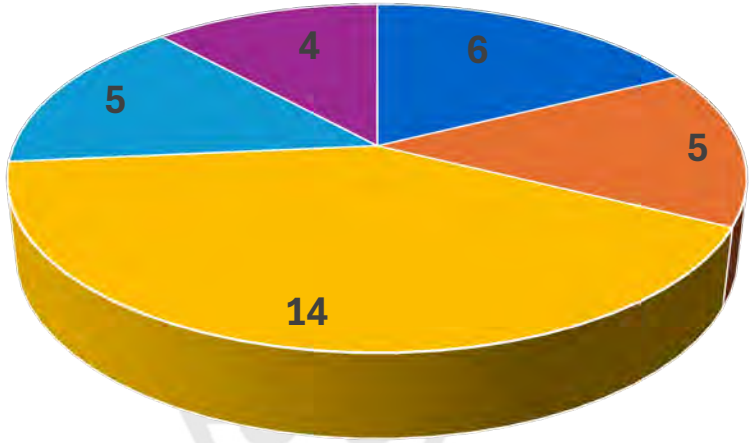
FACULTY OF MECHANICAL ENGINEERING CTU IN PRAGUE

Data about FME

- **Turnover 34 mil Eur, 2024**
  - Teaching 6 mil Eur
  - Institutional support for research 5 mil Eur
  - Projects 14 mil Eur
  - Contracts 5 mil Eur
  - Others (scholarships etc.) 4 mil Eur



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  Contracts 4 mil Eur

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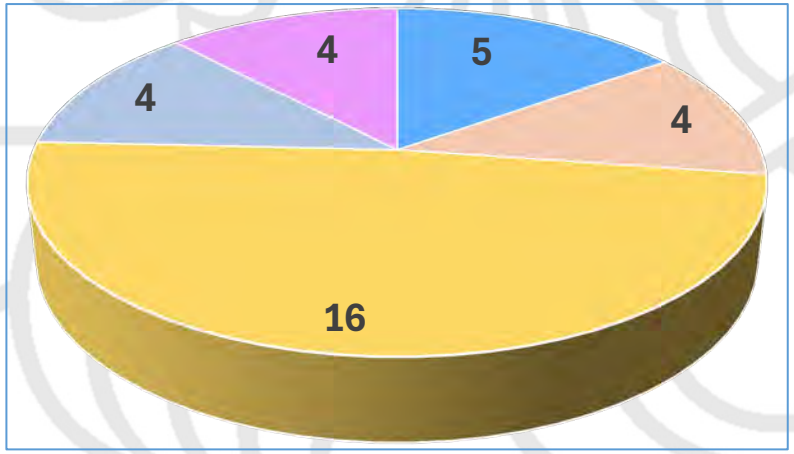


FACULTY OF MECHANICAL ENGINEERING CTU IN PRAGUE

EC projects 2014 – 2022 : compared total amount 49.0 mil Eur

Provider	Title	2014	2015	2016	2017	2018	2019	2020	2021	2022
EC	INTElligent FIXture for the manufacturing of low rigidity components	49,4	29,9	3,6						
EC	Integration and Management of Performance and Road Efficiency of Electric Vehicle Electronics	33,3	56,5	7,0						
EC	New materials and control for a next generation of compact combined solar and heat pump systems with boosted energetic and exergetic performance	22,3	5,0							
EC	Dynamic manufacturing of thin-walled work pieces by Milling process	82,0	8,4							
EC	Sustainable Hydrothermal Manufacturing of Nanomaterials	30,7	5,9	2,8						
EC	Damage risk assess in the times of clim									
EC	Centre for civil nucl									
EC	Development of adv									
EC	Large-volume trans									
EC	Research centre for low-carbon energy technologies					1836,8	1945,0	1945,0	1945,0	1940,0
EC	Center of Advanced Aerospace Technology					26700,4	2710,0	2710,0	2710,0	2708,0
EC	TURBOmachinery REtrofits enabling FLEXible back-up capacity for the transition of the European energy system				87,6					
EC	ADvancing user acceptance of general purpose hybridized Vehicles by Improved Co									
EC	Future Research, Advanced Development and Implementation Activities for Road T									
EC	IMplementation of Powertrain Control for Economic and Clean Real driving emIssion and fuel consUmption			15,7		14,0				
EC	Flexible Fossil Power Plants for the Future Energy Market through new and advanced Turbine Technologies			106,6	43,3					
EC	Real World Advanced Technologies for Diesel Engines			28,7	26,0					
EC	Gas-Only internal combustion engines		41,6		63,6	59,9				
EC	The innovative system for coke oven wastewater treatment and water recovery with the use of clean technologies			49,7						
EC	Clothes Perception and Manipulation	61,4								
EC	Development optalmo endoscope					6,0				
EC	Research and development of diesel aircraft engines				37,8	175,1				
EC	City Air Remote Emission Sensing						27,9	27,9	27,9	
EC	You can also reduce emissions						28,4	28,4	28,4	
EC	Safety of GFR through innovative materials, technologies and processes							60,2	60,2	60,2
	TOTAL (ths Eur)									**49089,0**

Title	2018	2019
Center of advanced aerospace technology (exceptional income to build aircraft engine test facilities)	26.7 mil Eur	2.7 mil Eur

Comparable amout = 49.0 – 26.7 +2.7 =25.0

FACULTY OF MECHANICAL ENGINEERING CTU IN PRAGUE

EC projects 2014 – 2022 : comparable amount 25.0 mil Eur
EC projects 2019 – 2027 : comparable amount 28.5 mil Eur

Provide	Title	2019	2020	2021	2022	2023	2024	2025	2026	2027
EC	Center of Advanced Aerocraft Technology	2,710.0	2,710.0	2,710.0	2,708.0	0.0	0.0	0.0	0.0	0.0
EC	Research centre for low-carbon energy technologies	1,945.0	1,945.0	1,945.0	1,940.0	0.0	0.0	0.0	0.0	0.0
EC	Machine Tools and Precision Engineering	287.0	371.0	461.0	603.0	0.0	0.0	0.0	0.0	0.0
EC	IMplementation of Powertrain Control for Economic and Clean Real driving emIssion and fuel ConsUMption	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EC	ADvancing user acceptance of general purpose hybridized Vehicles by Improved Cost and Efficiency	73.4	68.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EC	Future Research, Advanced Development and Implementation Activities for Road Transport	10.2	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EC	TURBOmachinery REtrofits enabling FLEXible back-up capacity for the transition of the European energy system	46.7	54.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EC	Safety of GFR through innovative materials, technologies and processes	0.0	60.2	60.2	60.2	0.0	0.0	0.0	0.0	0.0
EC	City Air Remote Emission Sensing	27.9	27.9	27.9	0.0	0.0	0.0	0.0	0.0	0.0
EC	You can also reduce emissions	28.4	28.4	28.4	0.0	0.0	0.0	0.0	0.0	0.0
EC	The Integrator-centric approach for realising innovative energy efficient buildings in connected suistainable green neighbourhoods	0.0	0.0	0.0	11.3	19.9	9.0	19.0	1.0	0.0
EC	Sustainable production of Cellulose-based products and additives to be used in SMEs and rural areas	0.0	0.0	0.0	0.0	0.0	0.2	7.9	0.0	0.0
EC	A Global as well as Local Flexibility Marketplace to Demonstrate Grid Balancing Mechanisms through Crosssectoral Interconnected and Integrated Energy Ecosystems enabling Automatic Flexibility Trading	0.0	0.0	0.0	0.0	16.6	18.7	44.2	86.8	0.0
EC	InnovAtive DeMonstrator for hyBrid-Electric Regional Application	0.0	0.0	0.0	0.0	280.0	282.0	282.0	66.0	0.0
EC	Green Intelligent Affordable New Transport Solutions	0.0	0.0	0.0	0.0	0.0	35.4	92.0	93.0	50.0
EC	LASERWAY : EXTREMELY HIGH-SPEED LASER AT THE RIGHT PLACE AT THE RIGHT TIME	0.0	0.0	0.0	0.0	0.0	130.4	122.0	118.0	0.0
EC	Twinning for Excellence in Morphing and Aero-Mechatronic Wing Control: A Leap Towards Eco-Smart Aviation	0.0	0.0	0.0	0.0	0.0	53.2	252.0	252.0	170.0
EC	Towards reliable and safe GFR	0.0	0.0	0.0	0.0	0.0	8.4	70.8	70.8	70.8
EC	Bioinspired cellular actuators	0.0	0.0	0.0	0.0	0.0	0.0	51.0	125.0	122.0
EC	Development of sustainable low-NOx and high efficiency Ammonia marine engine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	49.0	82.0
EC	Robotics and advanced industrial production	0.0	0.0	0.0	0.0	0.0	258.1	305.0	282.0	255.0
EC	Mechanical engineering of biological and bio-inspired systems	0.0	0.0	0.0	0.0	24.0	102.0	101.0	164.4	101.0
EC	New generation of universal hole grinders BUB Multi Plus series, Phase II	0.0	0.0	0.0	0.0	0.0	115.9	210.9	114.0	0.0
EC	Research and development of diesel aircraft engines	56.2	41.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EC	Research and development of an aircraft engine prototype	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EC	Development optalmo endoscope	58.4	30.2	7.1	0.0	0.0	0.0	0.0	0.0	0.0
EC	Development of Hybrid Drive System for the Aerospace Industry	0.0	61.7	71.0	86.1	1.4	0.0	0.0	0.0	0.0
EC	Using machine vision for automatic measurement when cutting rolled sheets	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EC	Image recognition for rolling process control	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EC	Development of high performance electric propulsion unit for CS-23 class aircraft	0.0	0.0	80.6	151.5	161.5	0.0	0.0	0.0	0.0
EC	SMART Hestego - Parameterization of new products and automation of the process of development, design and introduction into production	0.0	0.0	114.4	112.5	91.1	0.0	0.0	0.0	0.0
EC	The new generation of universal center lathes of the FLEXI series	0.0	0.0	131.8	64.9	124.1	0.0	0.0	0.0	0.0
EC	Linear hydraulic actuators for demanding applications	0.0	0.0	23.7	130.4	100.9	0.0	0.0	0.0	0.0
EC	Automated wear determination of machine tool during variable process conditions	0.0	0.0	11.5	75.7	94.1	0.0	0.0	0.0	0.0
EC	Energetically effective covering 2: Lamination cover with flexibly bound motion and telescopic covering with fluid support	0.0	0.0	17.1	71.1	78.1	0.0	0.0	0.0	0.0
EC	Variable Valve Actuation for Heavy Duty Diesel Engines	0.0	0.0	61.5	158.6	79.2	0.0	0.0	0.0	0.0

FACULTY OF MECHANICAL ENGINEERING CTU IN PRAGUE

Research at the faculty

Ph.D. study programmes

- Applied sciences in Mechanical engineering (Applied mechanics – solid and fluid, Mathematical and physical engineering, Biomechanics)
- Design engineering and mechatronics (design engineering, transport and production machines, mechatronics, robotics)
- Production and material engineering (manufacturing technology, materials, management and economist)
- Energy and process engineering (power machines, nuclear power plants, process engineering, enviromental engineering)
- Machine and process control

These areas of Ph.D. study are also the main areas of research at FME.

FACULTY OF MECHANICAL ENGINEERING CTU IN PRAGUE

Involvement in national research programs

FME in 6 NCC from 18 in CR = cooperation potential and interests of industry

1	Božek Vehicle Engineering National Center of Competence	2023	2028
	Josef Bozek National Center of Competence for Surface Vehicles	2018	2022
2	National Centre of Competence ENGINEERING	2023	2028
	National Centre of Competence ENGINEERING	2019	2022
3	National Competence Centre for Aeronautics and Space	2023	2028
	National Competence Centre for Aeronautics and Space	2019	2022
4	Centre of Advanced Electron and Photonic Optics	2023	2028
	Center of electron and photonic optics	2019	2022
5	National Centre for Energy II	2023	2028
	National Centre for Energy	2018	2022
6	National Competence Centre of Mechatronics and Smart Technologies for Mechanical Engineering	2023	2028
	National Competence Centre of Mechatronics and Smart Technologies for Mechanical Engineering	2019	2022

FME in 2 projects of top-level basic researchg OP JAK

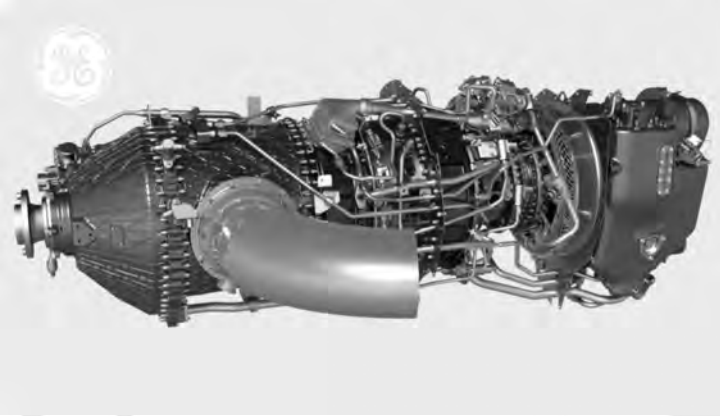
1	BIODEGRADABLE: Platform for modern implantology - research on individualized biodegradable materials	2024	2029
2	Mechanical engineering of biological and bio-inspired systems	2023	2028

FACULTY OF MECHANICAL ENGINEERING CTU IN PRAGUE

FME research ecosystems

Czech government asked us to develop **ecosystem for aerospace** in order to enable opening of new General Electric turboprop division including R&D in the Czech Republic:

- We developed 5 large test cells and carried out many tests
- GE Aviation Czech certified Catalyst engine
- Production and Euromale R&D in the Czech Republic



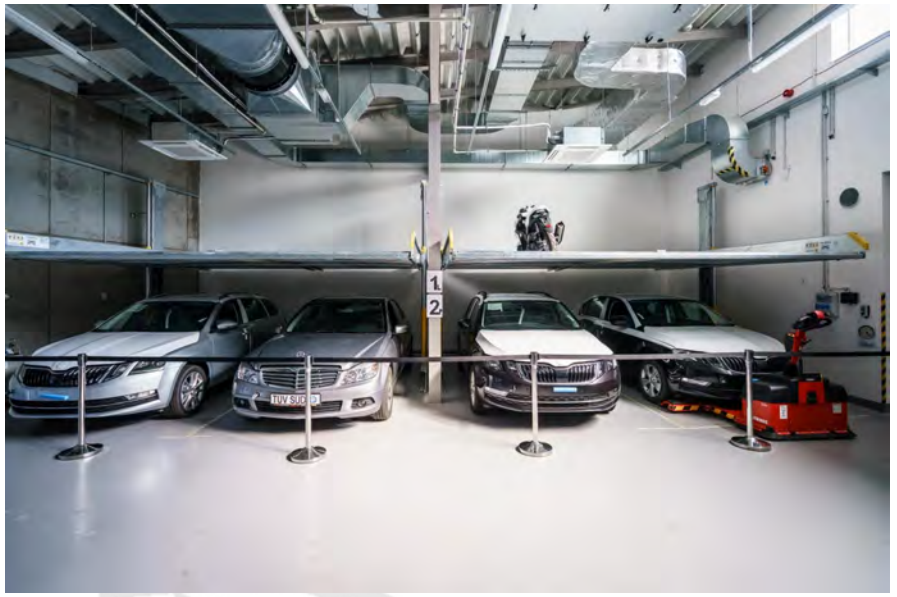
FACULTY OF MECHANICAL ENGINEERING CTU IN PRAGUE

FME research ecosystems

The center for sustainable mobility vehicles

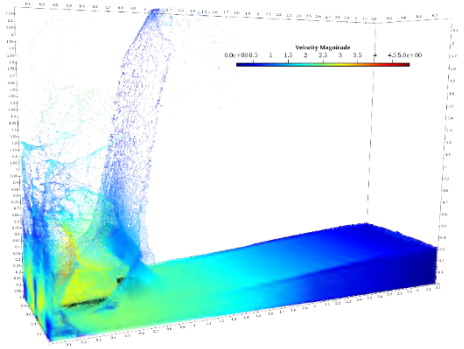
Since 2019 we utilize conditioning hall built in cooperation with TUV SUD

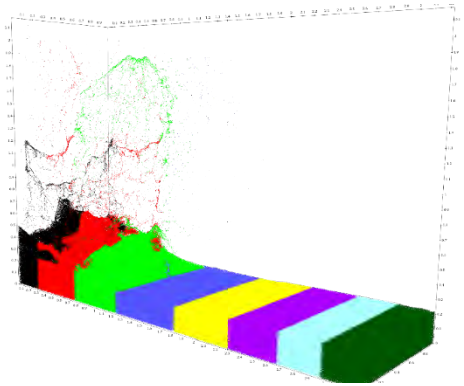
- Expansion of the laboratory space by the conditioning hall was forced by new legislative requirements for vehicle testing.
- legislative requirement for vehicle tempering before/between tests - applies to both vehicles with ICE and with various levels of electrified drive, including pure BEV, which is (depending on the type of drive) contained in various annexes and amendments to the regulations listed below
- Regulatory base for passenger vehicles:
  - EC 2017/1151 (Euro 6) vč. 2023/443
  - regulation UNR (EHK OSN) Nr. 154 (WLTP) and 168 (RDE)
  - 2024/1257 (Euro 7, already in effect) + its implementing regulation, which is technically based on Euro 6
- regulations with almost identical temperature stabilization requirements for motorcycles and their "derivatives":
  - EC 134/2014 vč. 2023/2724

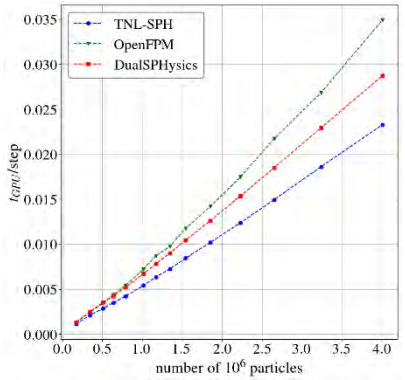


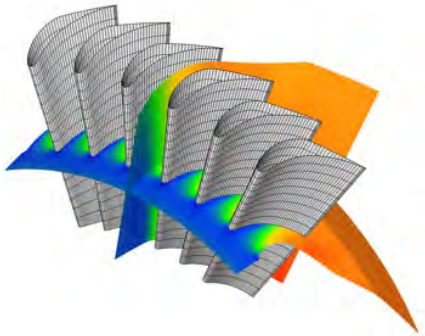
FACULTY OF MECHANICAL ENGINEERING CTU IN PRAGUE

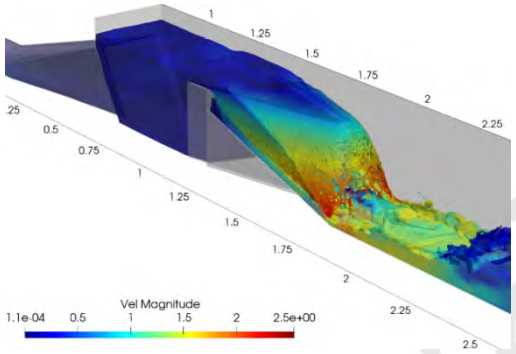
Research in laboratories of FME CTU

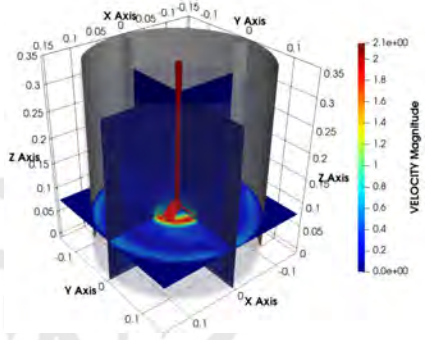


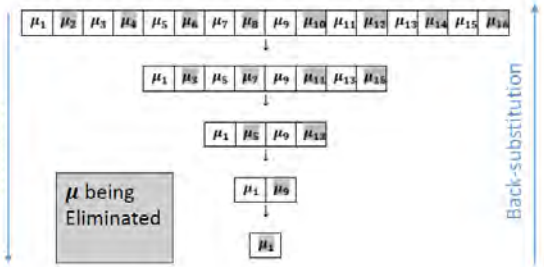


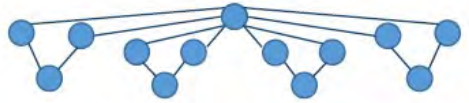


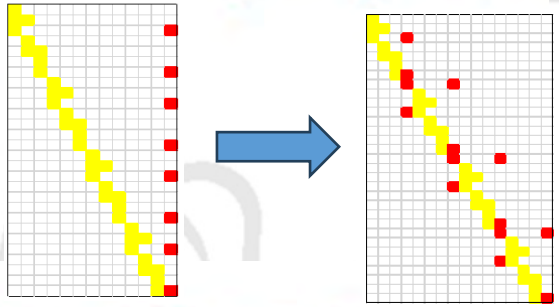


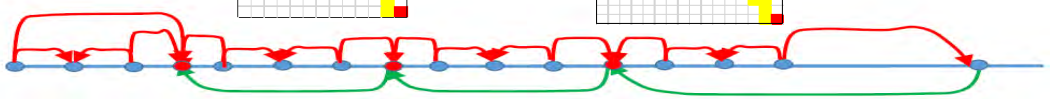












High fidelity simulations.

- The development of methods and software (SPH, MD, DPD, GFDM DEM, DPM, LBM
- Applications: simulation of blade grilles, pumping stations, mixing devices

Parallelization of engineering problems

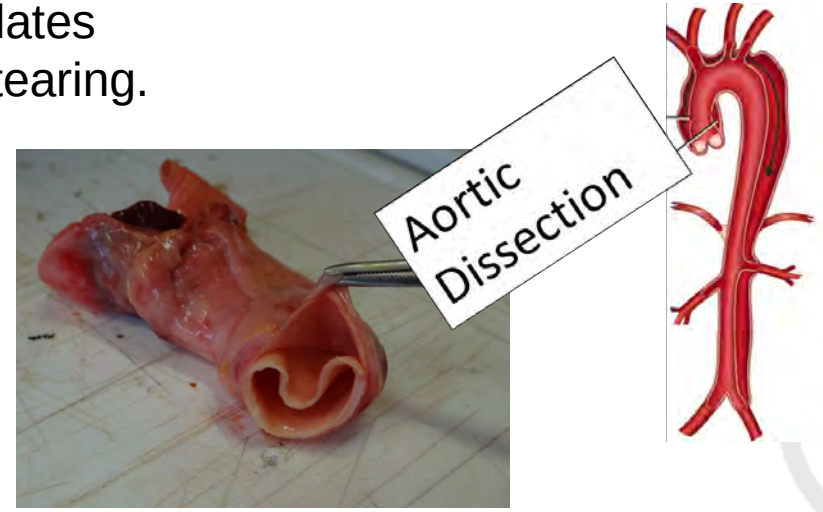
Quantum computing envisaged

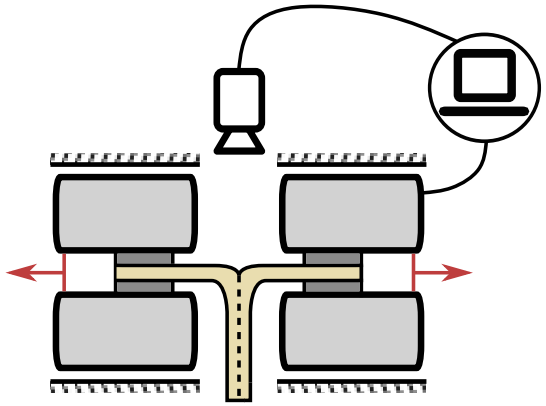
FACULTY OF MECHANICAL ENGINEERING CTU IN PRAGUE

Research in laboratories of FME CTU

Aortic dissection spreads as a crack along the aortic axis

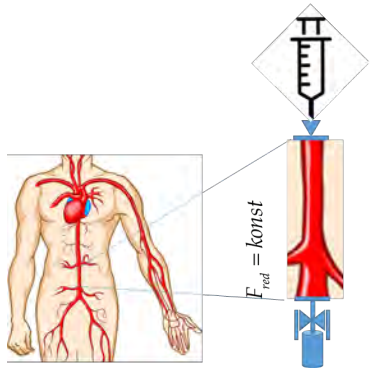
The delamination strength is determined in a peeling experiment that simulates wall tearing.

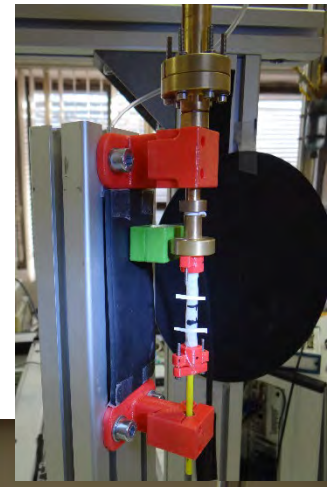


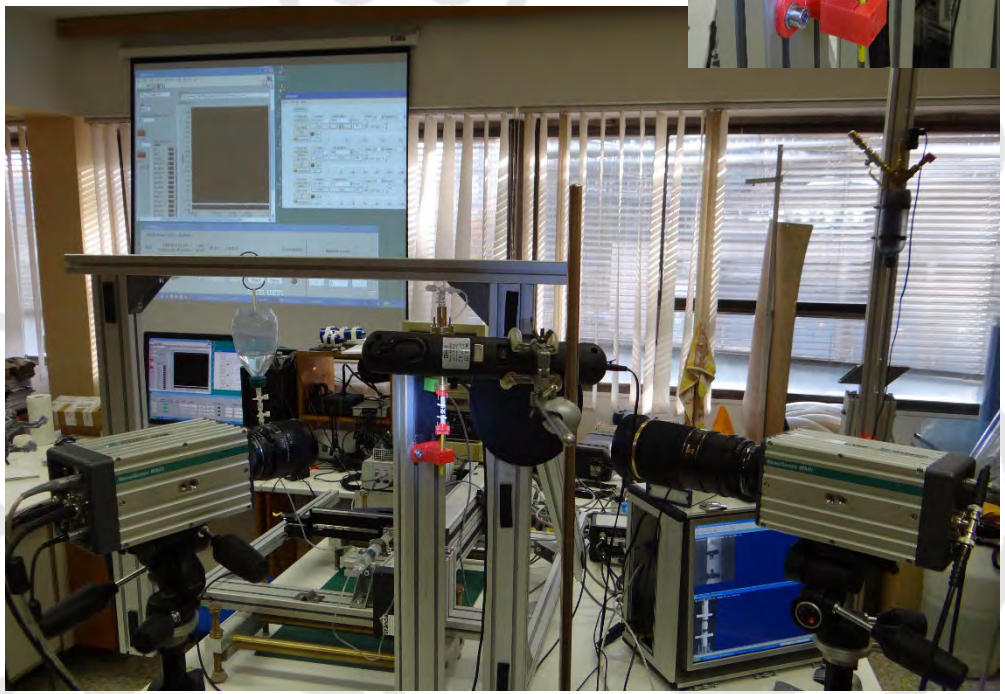


Inflation experiment

Tube pressurization is a primary experiment for determining the properties of blood vessels and their artificial substitutes

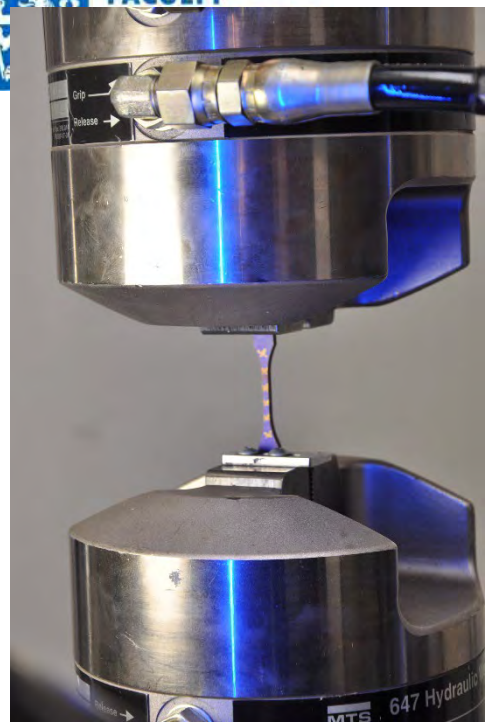






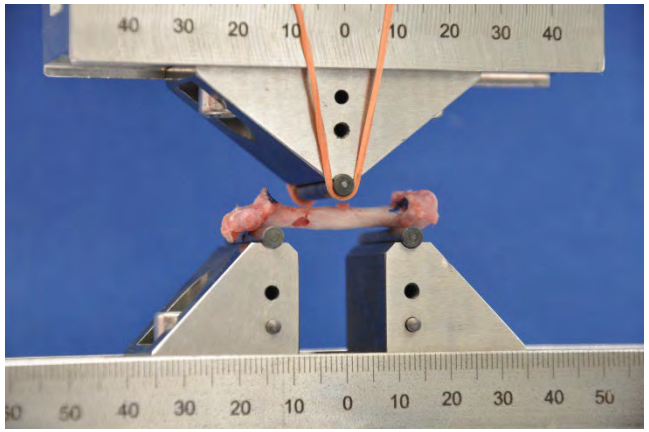
FACULTY

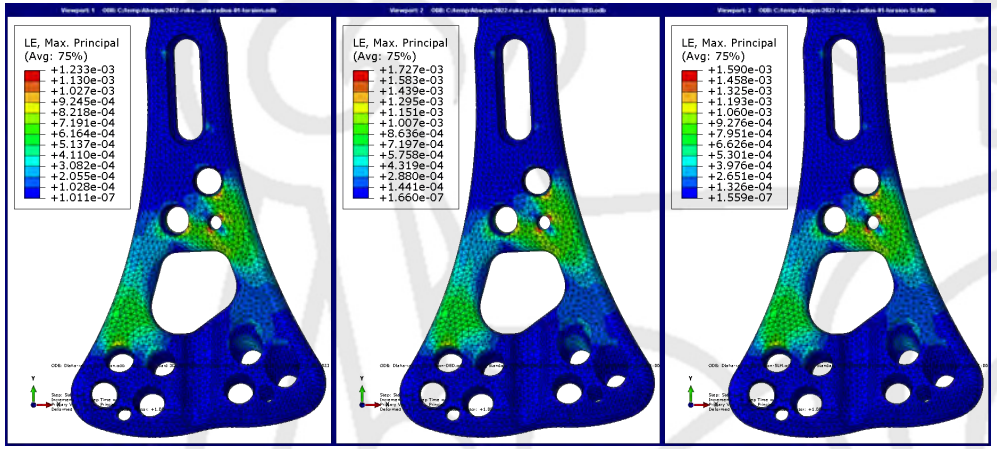
Research in laboratories of FME CTU

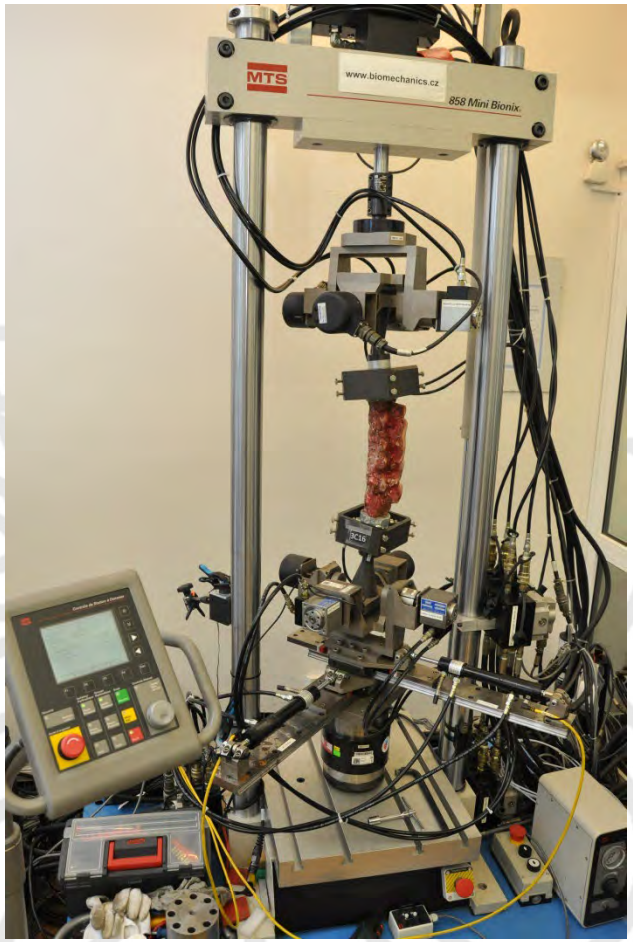


Experimental Biomechanics

- Mechanical properties of bone
- Stiffness of pork spine
- Tensile testing materials for implants
- Development of new fixation of radius - FEM analysis of radial fixation for distal forearm fracture

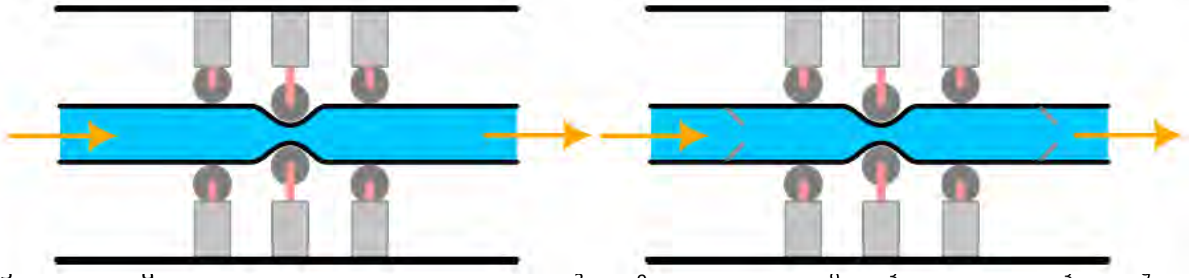


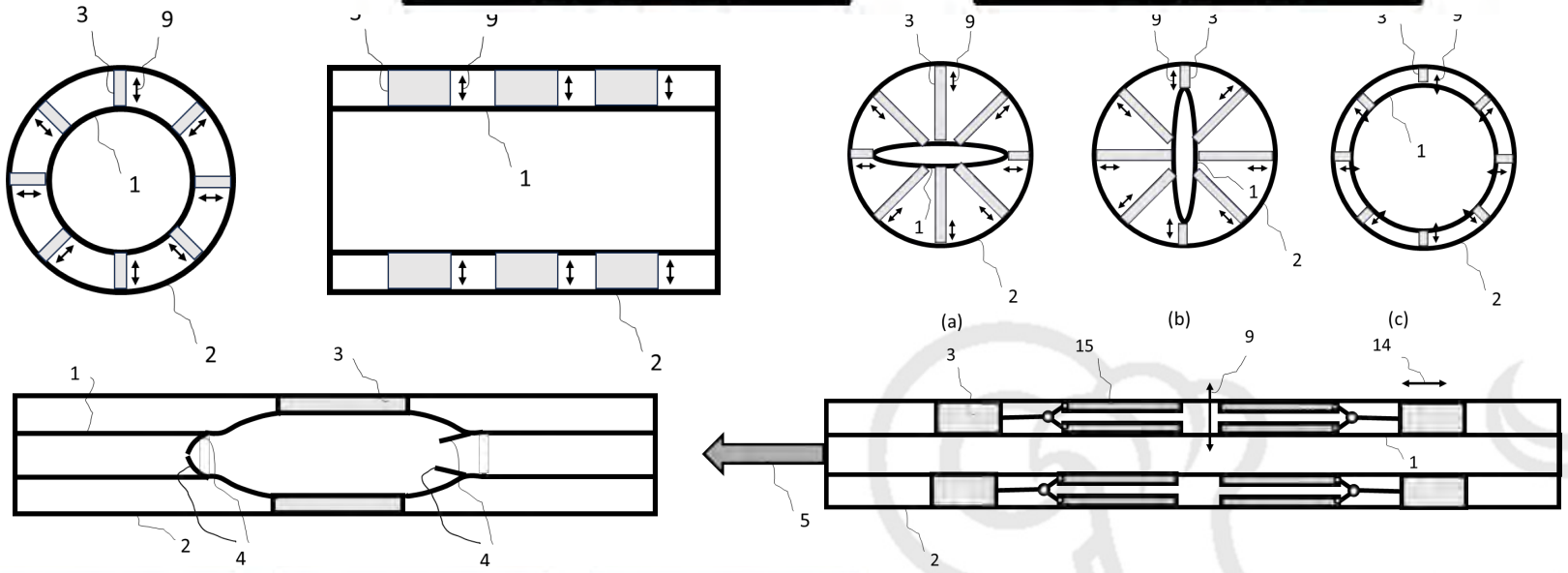


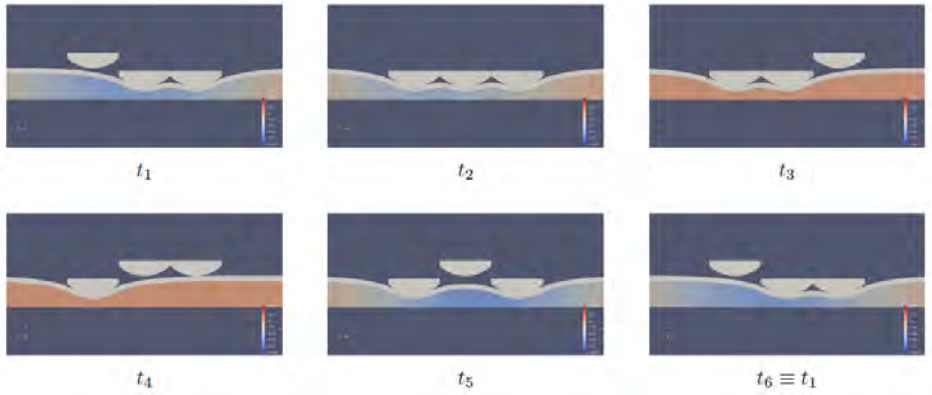


FACULTY OF MECHANICAL ENGINEERING CTU IN PRAGUE

Research in laboratories of FME CTU



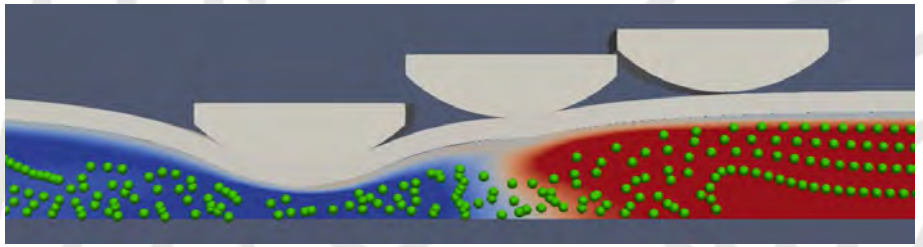




Bio-inspired structures

Novel concept of peristaltic pump based on mechatronic stiffness

Patent pending



Advanced simulations

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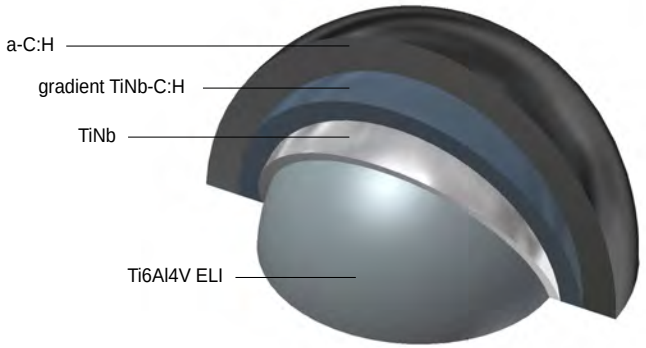
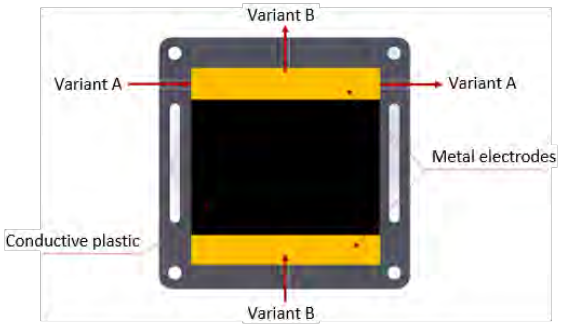
Research in laboratories of FME CTU

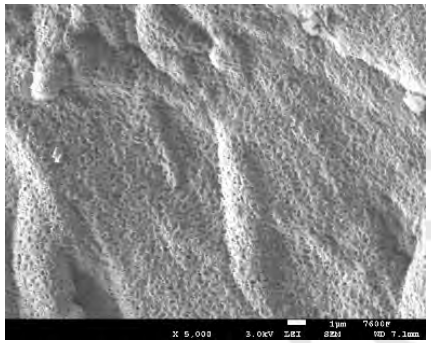
Materials research

DLC and TiNb-DLC coatings for 3D printed oncology implants



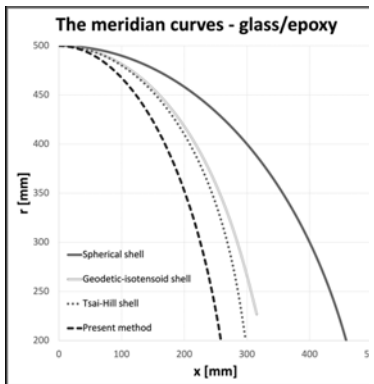
Nanostructured surface of PEEK implants formed by anodic oxidation of titanium-based coatings





Cu coatings on conductive plastics for automotive applications

Patent pending

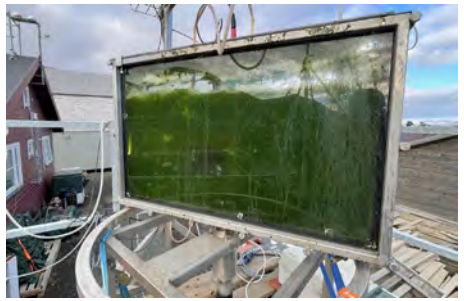


Load carrying composite structures.

Contribution to the theory of thin-walled composite vessel.

Application - semi-intelligent composite containers.

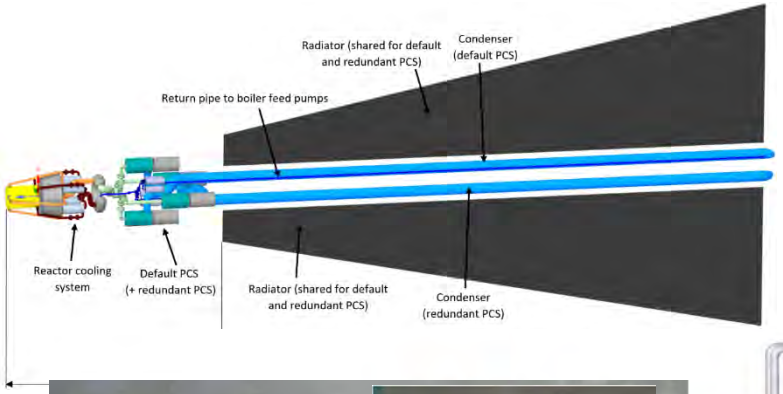
Research in laboratories of FME CTU

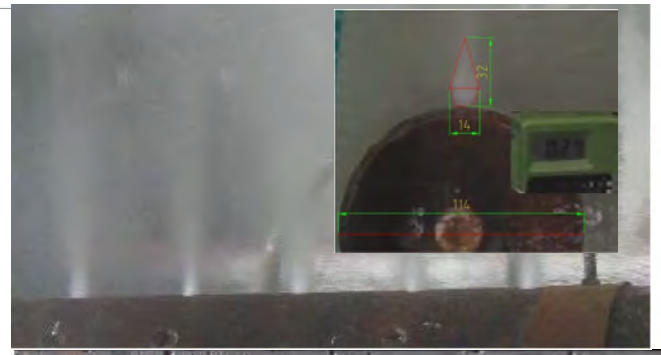


Carbon Capture and Utilization Technologies

- Transport Phenomena & Predictive PBM Modelling.
- Advanced Pretreatment Technologies.
- Modular Smart Reactors & Bioreactors.
- Sustainable Biorefinery Concepts (Waste-to-X, Power-to-X, Green-chemistry production)
- Post-combustion CO_2 capture
- Oxy-combustion processes and fludized bed systems
- Control of pollutants, processes and materials for CO_2 purification

Research in laboratories of FME CTU



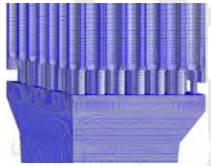


Nuclear energy applications. .

Development of innovative nuclear solutions:

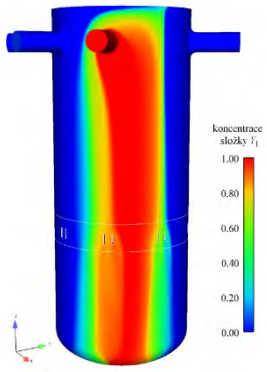
- Small modular reactors
- Space reactors
- Next generation nuclear reactors
- Fusion reactors.

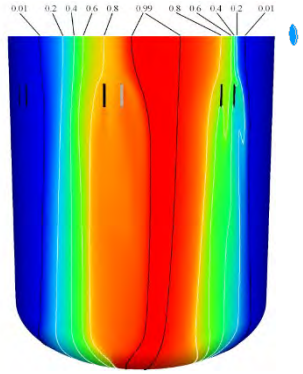
Experimental research of related phenomena: critical heat flux, quenching, mixing among fuel channels, etc.

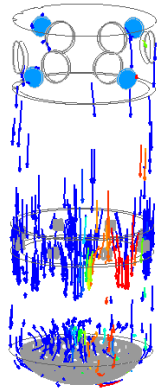


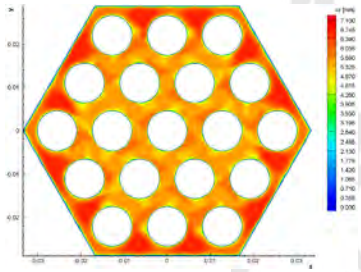
Simulations of reactor thermal hydraulics

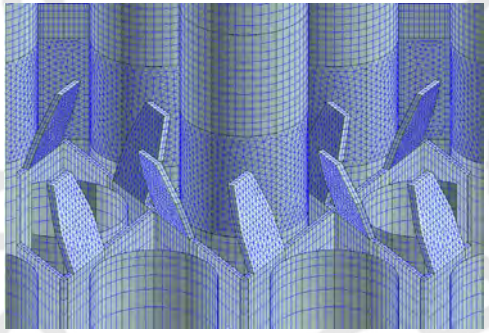
Nuclear fuel and reactor vessel modelling.







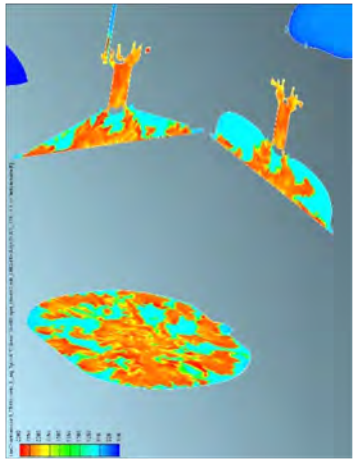




Application – Support of safe operation of current nuclear power plants and new nuclear applications.

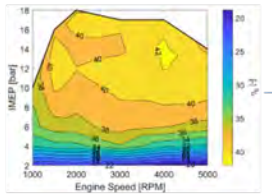
FACULTY OF MECHANICAL ENGINEERING CTU IN PRAGUE

Research in laboratories of FME CTU



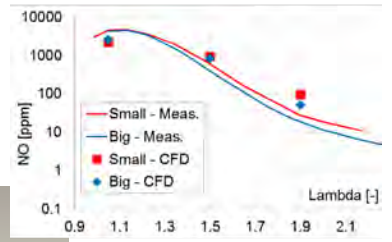
Experimental data

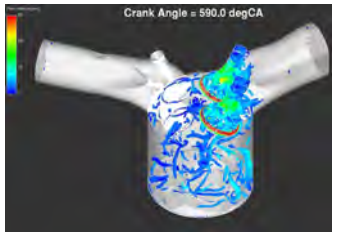
Equivalent 4-cyl engine

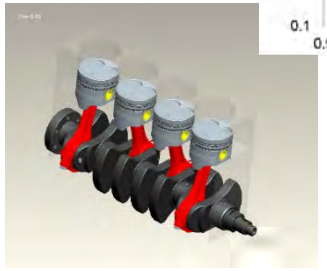


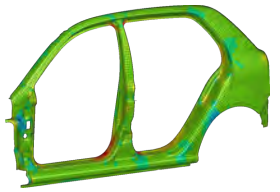
Quasi-steady WLTC simulation

NO formation





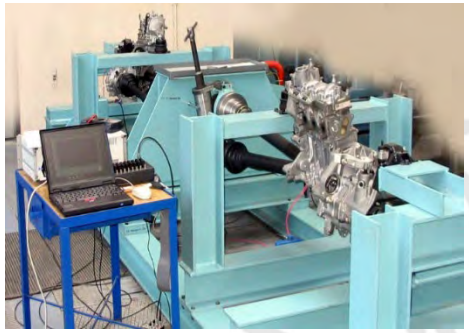




Engine Test Cells

Electric Drives

Gearbox Laboratories

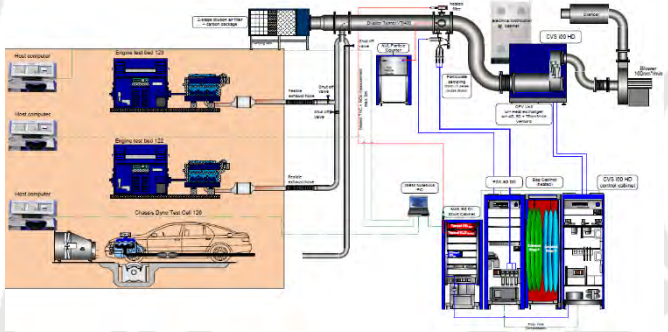


Rail bogie (scaled model)

Injection System Test Bench

Chassis Dyno 4WD

CVS Exhaust Gas Dilution System



Internal Combustion Engines

Low temperature combustion (higher efficiency, low pollutants) + turbocharging + hybridization + unconventional applications (e.g., DCDA, 2-stroke engine brake).

Powertrain Components

Gears + gearboxes + clutches + differentials + connecting shafts.

Vehicles Components

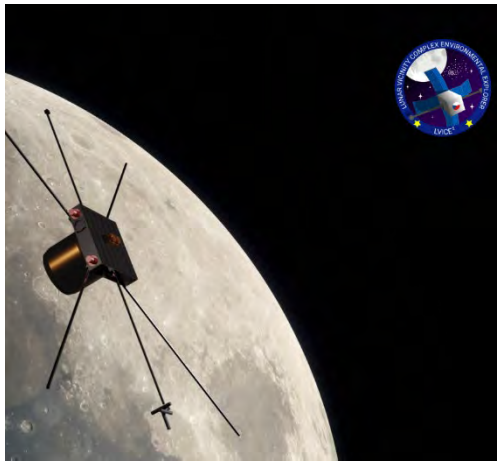
Cars and rail vehicles + their components (e.g., brakes, chassis, bogie) + safety + optimal control + design tools (DASY).

We perform Experimetns + Simulations + Design

FACULTY OF MECHANICAL ENGINEERING CTU IN PRAGUE

Research in laboratories of FME CTU

Space applications.



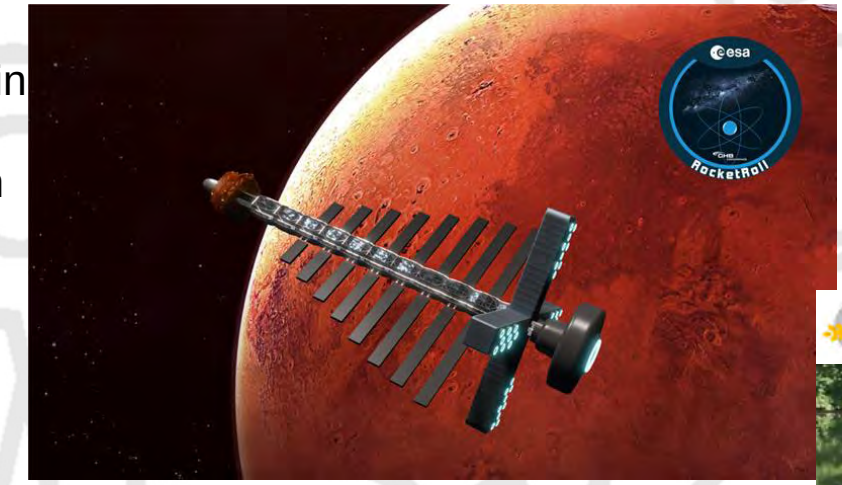
LVICE² (Lunar VIcinity Complex Environmental Explorer) - phase in ambitious Czech missions programme (via ESA). Study of plasma and radiation environment in a lunar wake, detection of Kordylewski dust clouds

METRO (MEtabolic gases TRansfer for Optimised algae growth) ESA progr., CTU as prime contractor. Selected into the set of experiments for the mission of the Czech astronaut on ISS. Photobioreactor with active gas exchange

Little Moon City Prague
CTU (FME, FEE, FBI) is now Main partner of the Unique European Training Centre for the simulation of space missions

Simulated space mission PROMISE with reserve astronaut Aleš Svoboda (2024)

We provide equipment for online monitoring of the state of the atmosphere inside the habitat



Simulations of reactor thermal hydraulic Nuclear fuel and reactor vessel modelling.

Simulated space mission
DIANA III - Moon Landing

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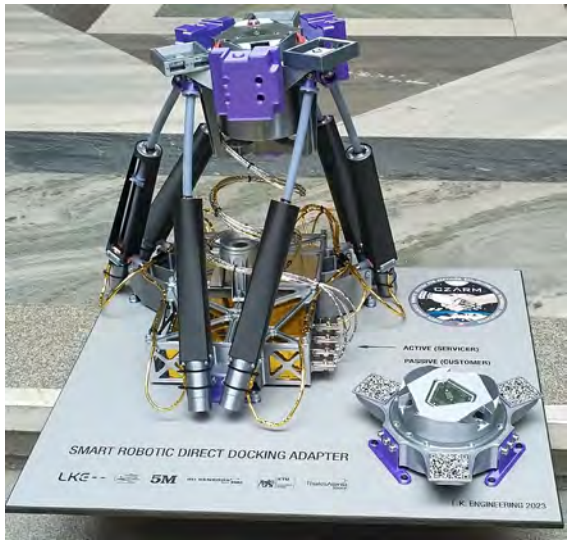
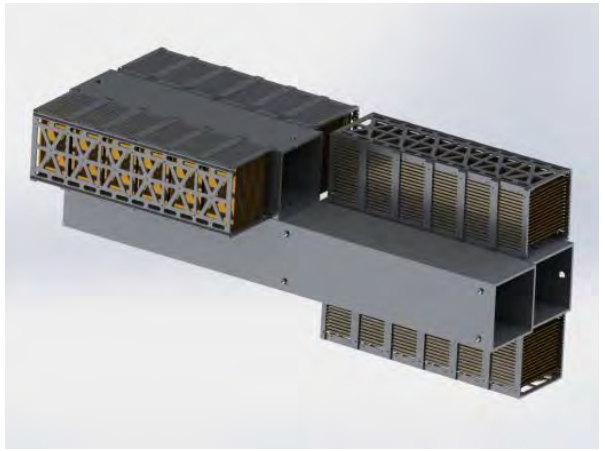
Research in laboratories of FME CTU

Space applications.

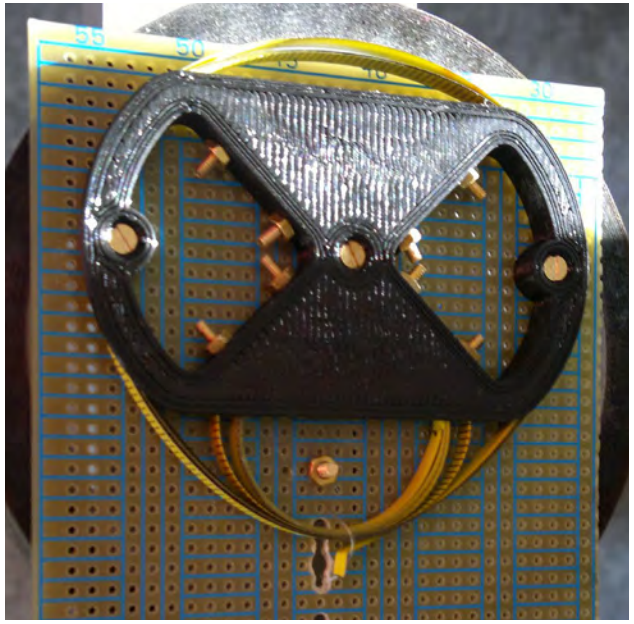


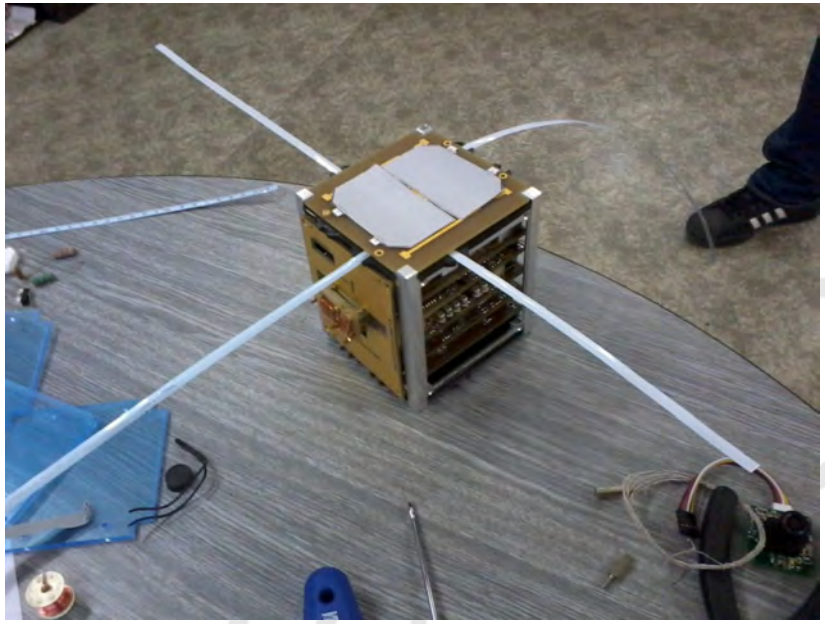
Czech Robotic Arm
for real commercial bussines in the Space!

The development of the **deployment mechanism of the mini dipole antenna** for VHF/UHF satellite CzechTechSat



Small satellite facility and payload. The analysis and functional testing of multi-foil optics properties developed by Rigaku Innovative Technologies Europe s.r.o





Planned testing collaboration with Penn State University

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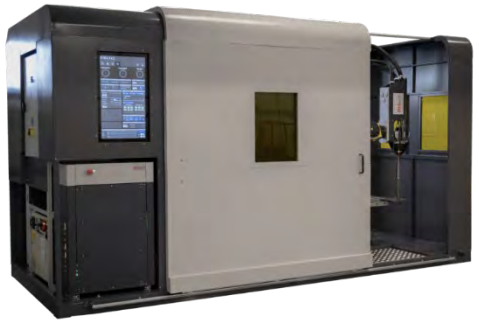
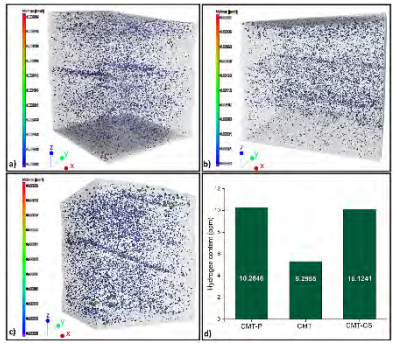
Research in laboratories of FME CTU

Manufacturing applications.

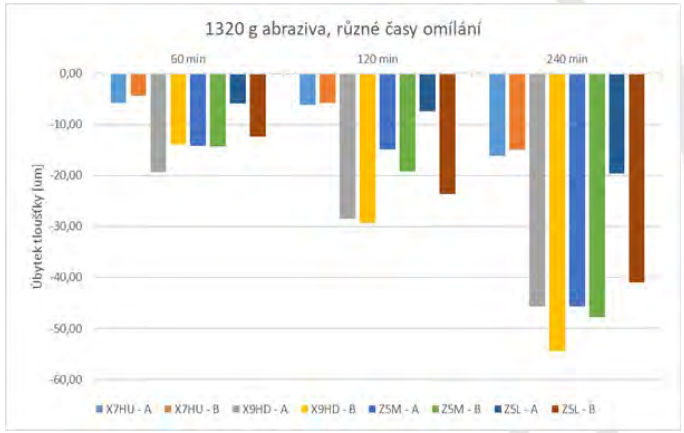




Metal Additive Manufacturing.
WAAM – Wire and Arc Additive Manufacturing, **W-LMD** technology used on Fanuc robotics arm with Meltio laser head technology

WeldPrint machine, developed by FME CTU+Kovosvit, **Applications**

Used for the development repair procedures of the worn-out track vehicle components.



- Verified technology for progressive polishing of bladed parts
- mathematical description of polishing technology
- development of specific process parameters for compressor parts
- development and production of clamping jigs and quality control system
- technical and economical analysis of finishing technologies

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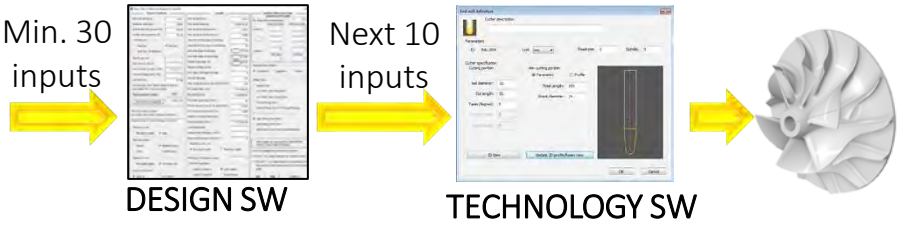
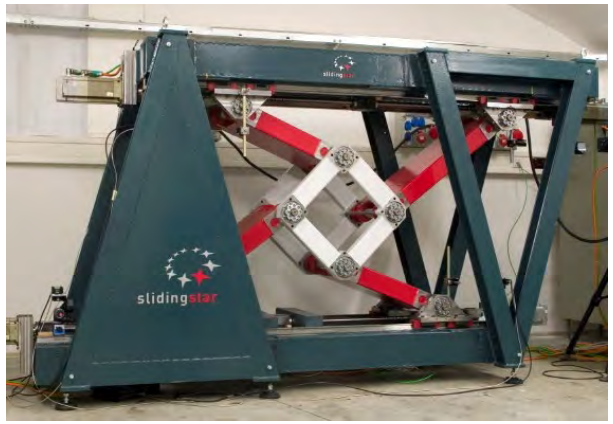
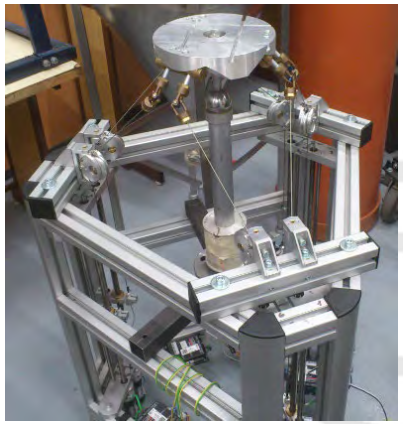
Research in laboratories of FME CTU

Design & manufacturing



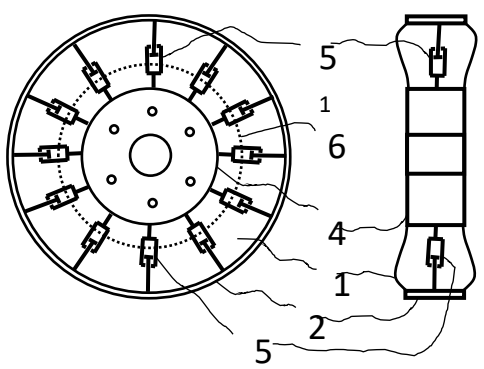
Effective design and production of high-efficiency compressor wheels for turbochargers

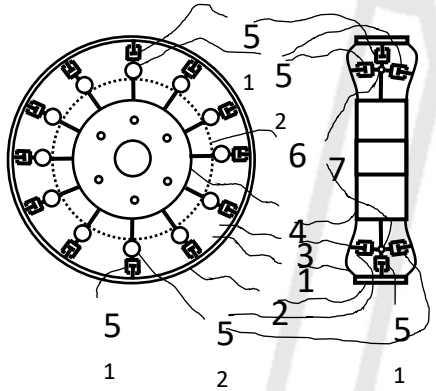




Mechatronics

Redundantly actuated parallel kinematics
Serious problem of robust control of redundantly actuated parallel kinematics solved by Sliding Mode Control





Actuators inside tyre
solve the conflict comfort-handling
Patent EP3022068B1

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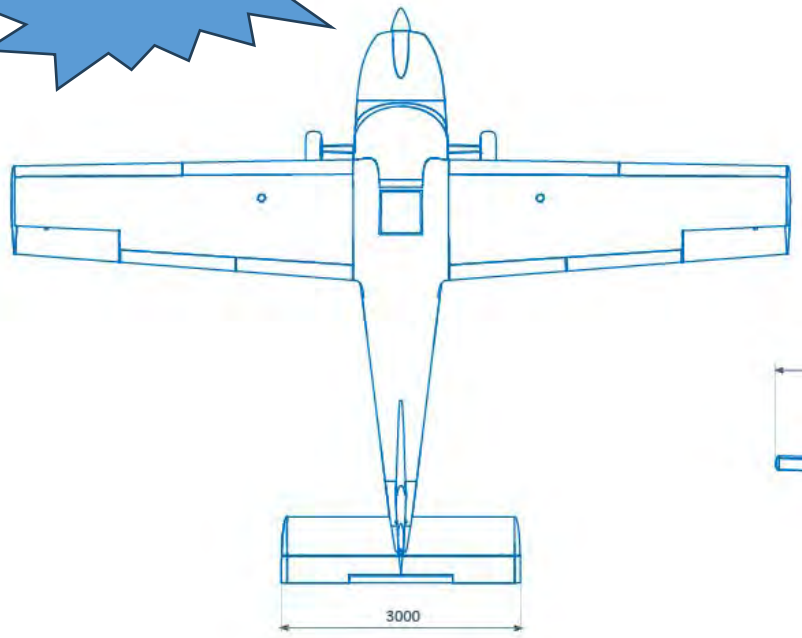
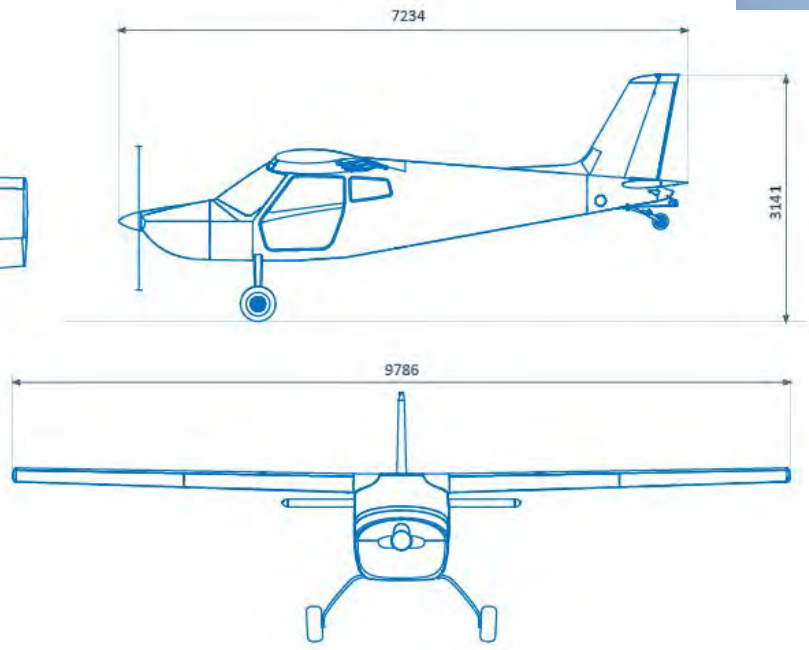
Examples Results of research

SHORT TAKE-OFF AND LANDING (STOL) AIRCRAFT
(collaboration with Direct Fly s.r.o.)

In SER

Thanks to a tailor-made high-lift system and an aerodynamically optimized design, this aircraft achieves significant fuel savings compared to other STOL aircraft in the LSA category, making it both more economical and environmentally friendly





Equipped with a 100 hp engine, the STOL Cruiser delivers the following performance:

- Maximum speed: 220–225 km/h
- Minimum speed: 40 km/h (depending on engine mode)
- Cruise speed: approx. 180 km/h

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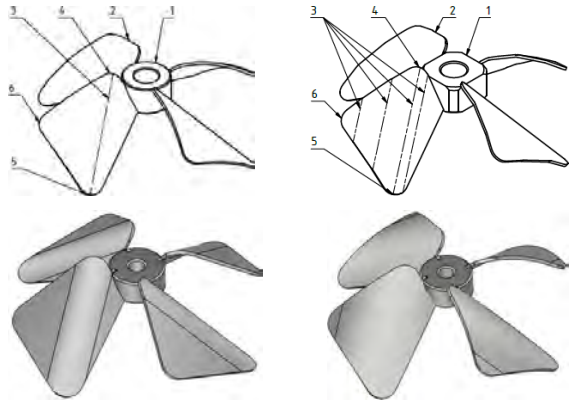
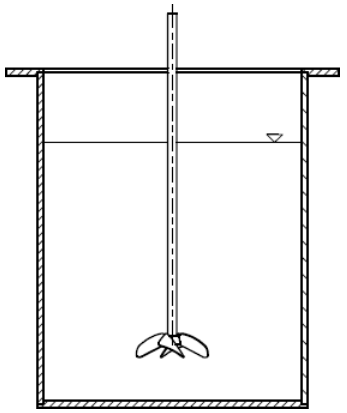
Examples of research results

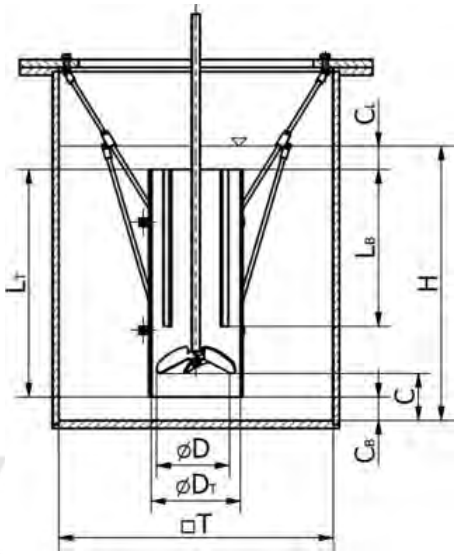
RESEARCH OF MIXING PROCESS AND EQUIPMENT
(TACR)

In SER

Impeller shape and location optimalization







The Czech patent was granted

Application examples

Flocculation tank in a wastewater treatment plant Brandýs n. L.

Pilot unit of the absorber for mercury capture from flue gases

Tank for the disinfection of water from breeding ponds

More that 10 other industrial applications according to licence agreement

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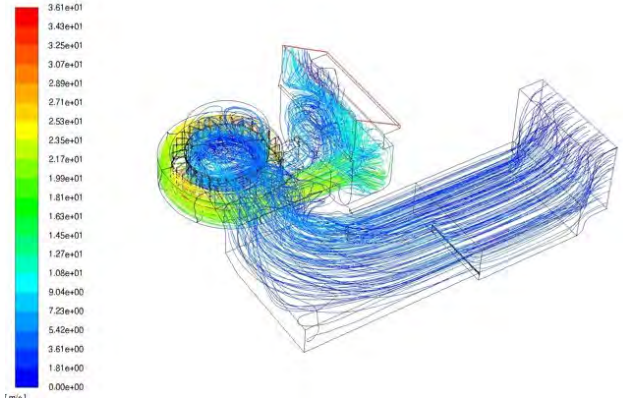
Examples of research results

LOCAL VENTILATION UNIT WITH A ROTARY RECUPERATIVE HEAT EXCHANGER

In SER

(collaboration with RECUAIR company)



International patent was granted

RECUAIR pages, result in the market: https://www.recuair.com/en/

Optimized air flow through the unit with respect to noise.

- Simulation results of airflow in inlet channel
- Initial design
- Room/facing part
- EPP cylinder with heat exchanger
- Passage through the wall

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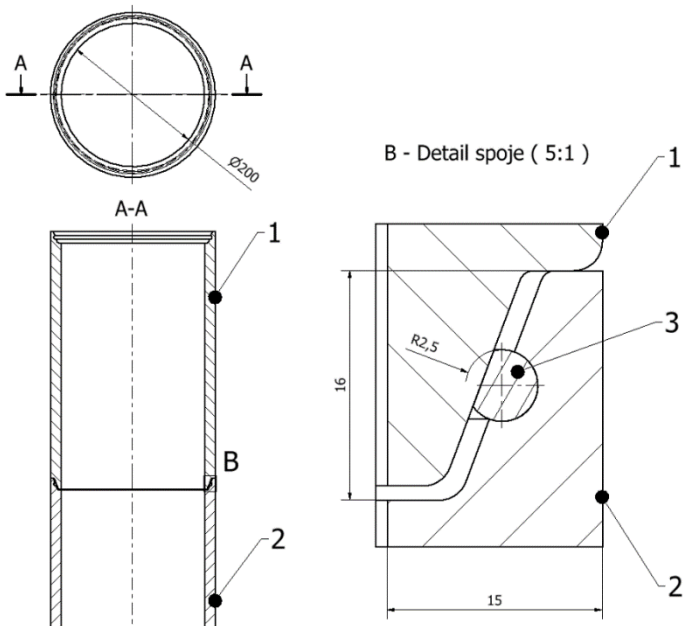
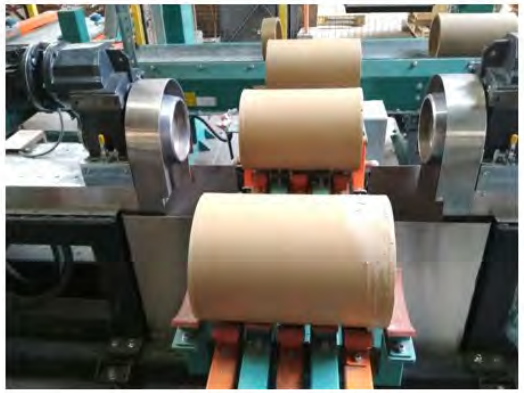
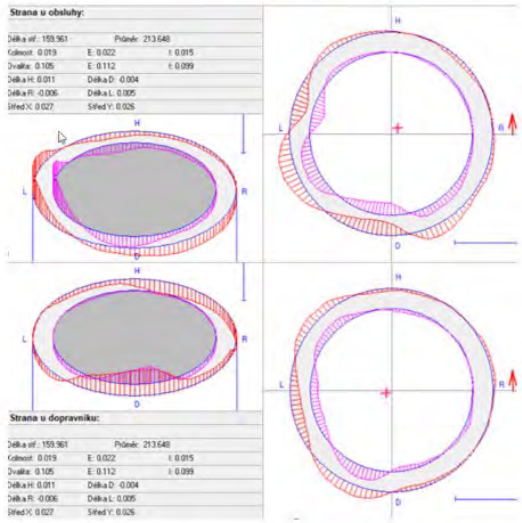
Examples of research results

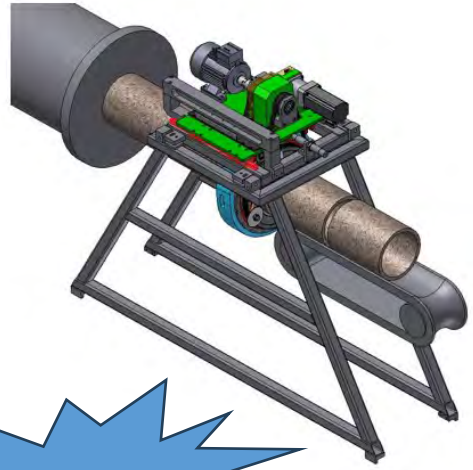
PROTOTYPE CHIMNEY SYSTEM WITH A NEW TYPE OF JOINT FOR W3G CHIMNEY SYSTEMS
(RHI Magnesita Czech Republic a.s., formerly P-D Refractories CZ a.s.)



Design of optional graphite sealant ring for the new seal/joint prototype







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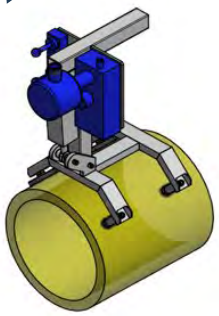

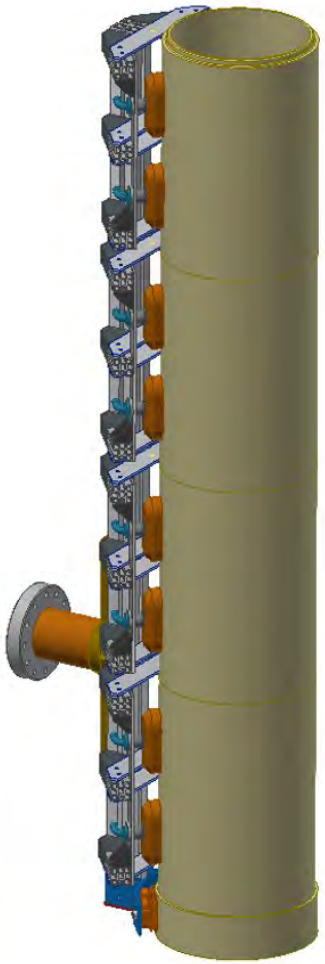

The resulting products based on the prototype chimney system are unique in their ratio of useful properties and price on the current market.

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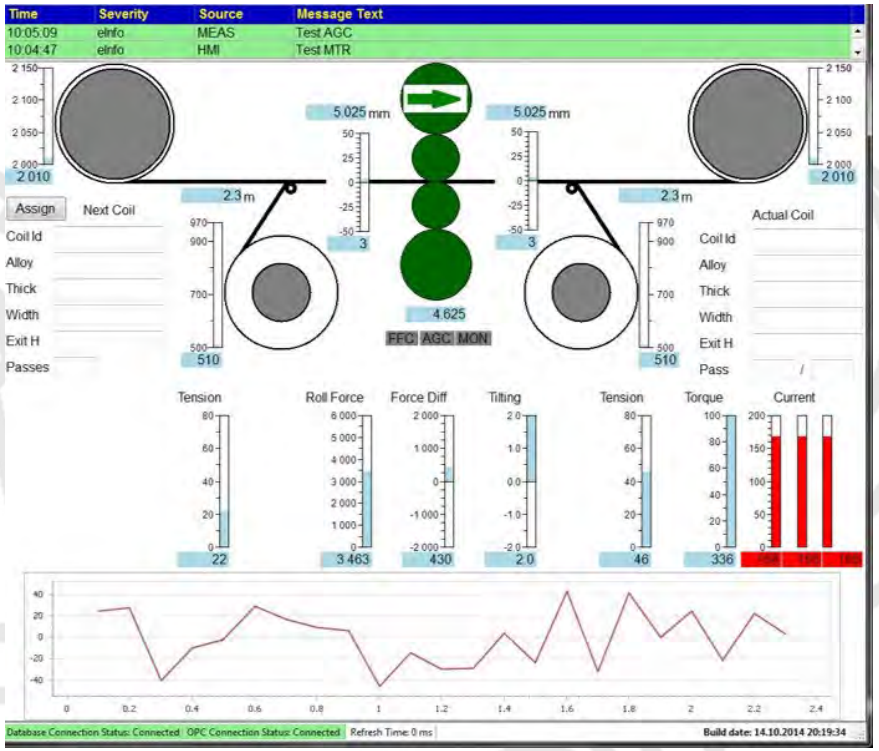
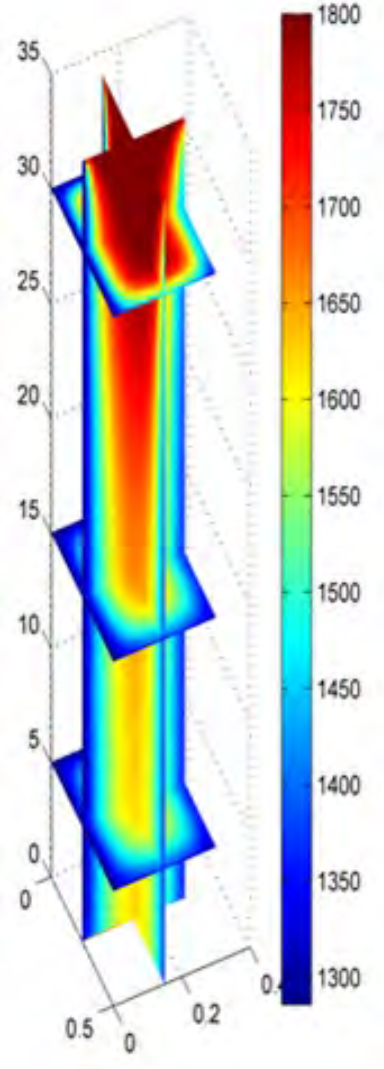
Examples of research results

MODULAR SOFTWARE PLATFORM FOR DISTRIBUTED PRODUCTION PROCESS MONITORING, CONTROL, AND OPTIMIZATION
(collaboration with
PT Solutions Worldwide, s.r.o.)

The software platform vertically integrates control systems from the lowest level of control, which is the controlled process itself and its basic measuring and actuators, through the level of basic automation with the help of industrial control machines, through the level of advanced control layer, to higher corporate and business control systems.

In SER





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Examples of research results

TOS VARNSDORF-2019 MACHINE TOOL MANAGEMENT SYSTEM
(collaboration with TOS VARNSDORF a.s.)

TOS Control is implemented on the Siemens Sinumerik 840D sl and Heidenhain TNC640 control systems

Inprocess measurement

The TOS Control machine management system creates a unified gateway to the world of digitisation and machine connectivity. TOS Control represents the basic machine system not only for the operator, but also for system integrators and software developers.

In SER

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Recent results examples, 2024 +

- Patent: **Compact apparatus for extracting water from air.** IL281352. 2025-01-05 ID: 363822.
- Patent: **A Method for Determining a Level of Wear of Welding Electrode Caps for Resistance Spot Welding and a Device for Performing this Method.** EP4045221. 2024-12-11. ID: 380524.
- Patent: **Heat recovery ventilation unit.** US12152800. 2024-11-26.
- Patent: **A method of working agricultural soil in the cultivation of wide-row crops and an equipment to perform the method.** CZ 310389. 2025-03-20**.**
- Verified technologies**: for low-pressure casting for various materials**
- Prototype**: Milling center of the MCFV series with the functionality of automatic monitoring of milling operations and decision-making with the support of a digital twin**
- Utility Model: **High ankle and leg brace.** CZ 37946. 2025-01-29
- Functional sample: **Experimental rig for determining gear mesh stiffness**
- Functional sample: **An absorbable composite bandage from polymer reinforcement and collagen matrix**
- Functional sample: Equipment for heat accumulation
- Contract: **Design of new factory for Sécheron Hasler – 2025**

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Faculty is open and supporting collaboration

- **FME was the co-founder of the CTU institutes**
  - **University Centre for Energy Efficient Buildings**
    - Department of Energy Systems of Buildings
  - **Czech Institute of Informatics, Robotics and Cybernetics**
    - Department of Industrial Production and Automation

- **FME** cooperates with all faculties and institutes of CTU in scope of common projects

- **FME cooperates with czech universities and research organizations:**
  - BUT Brno, UWB Pilsen, TU Liberec, TU Ostrava, UCHT, CAS (IT, HiLase laser applications …), SUSEN – Nuclear Research Center…

- **FME cooperates with foreign universities and research organizations:**
  - CERN – construction of physical experiments
  - Von Karman institute
  - DLR
  - Fraunhofer Institute for Machine Tools and Forming Technology (IWU)…
  - TUM
  - TUW
  - UniStuttgart
  - Polito …

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Conclusions

- FME is a technical university with clear mission and vision
- FME fulfills the goals and tasks from its mission and vision
- FME contributes to the competitiveness of Czech industry and thus Czech economy in global markets
- FME is trying to carry out basic research for solution of current problems in society such as transportation, energy&environment, circular economy, safety and security, defence
- FME is trying to contribute to ethical and social stability in society

Thank you for your attention

Discussion