

Faculty of Electrical Engineering University of West Bohemia in Pilsen

Space experience



FACULTY OF ELECTRICAL
ENGINEERING
UNIVERSITY OF WEST BOHEMIA

RICE

FACULTY OF ELECTRICAL ENGINEERING

Students

- Close to 800 including almost 80 international students from more than 15 countries

Study programs in 3 levels

- Bachelor / Undergraduate (in CS)
- Master / Graduate (in CS and EN)
- Ph.D. / Doctoral (in CS and EN)

Five departments of:

- Electronics and Information Technology
- Power Electronics and Machines
- Power Engineering
- Materials and Technology
- Electrical and Computational Engineering

Research center RICE (Research and Innovation Centre for Electrical Engineering)



Competence roadmap

Key Kompetences

- **Power electronics, drives and machines**
- **Material research**
- **Power engineering**
- **Electronics and embeded systems**
- **Industrial informatics / AI**
- **Computer modelling**
- **Diagnostics and testing**
- **Industrial informatics**
- **Physics instrumentation**

MAIN TARGET APPLICATIONS OF THE RESEARCH

Transportation

- Electric drives and traction systems
- Technology for road and rail vehicles, marine and aerospace transport systems
- Electromobility, power, and charging infrastructure
- Intelligent transport vehicles and systems
- Space technologies

Power Engineering

- Technology for transmission and distribution grids
- Nuclear technology
- Energy conversion, power, and heat generation
- Safety, reliability, and digitalisation
- Smart city technology

Industry

- Manufacturing technologies and processes
- Robotics and automation Sensors
- Wearable electronics and smart textiles
- Nanotechnology

FEL UWB SPACE PROJECTS AND EXPERIENCE

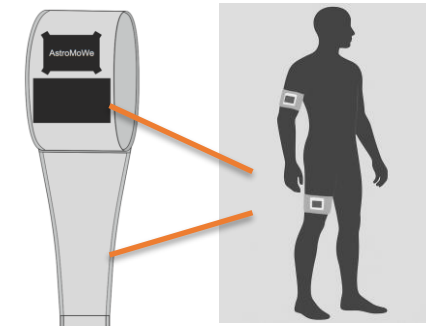
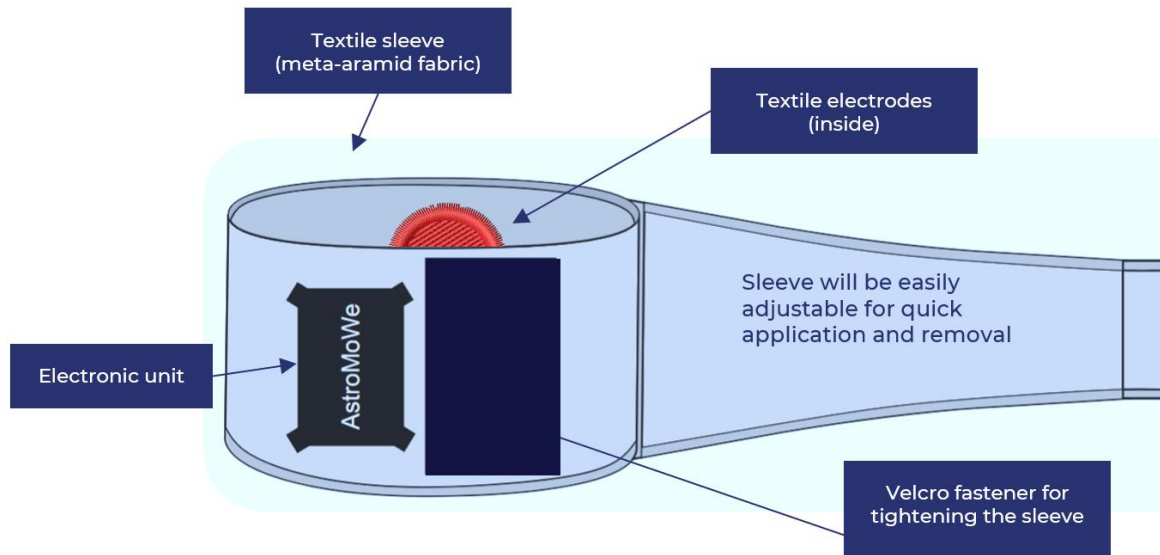
VZLUSAT - 1 and 2

- Project Lead: Aviation Research and Testing Institute (VZLU).
- Satellite Communications: University of West Bohemia in Pilsen,
- Other Partners: Esc Aerospace, Rigaku Innovative Technologies Europe, TTS, Advacam, Spacemanic, Eltvar, Needronix



FEL UWB SPACE PROJECTS AND EXPERIENCE

- Textile electrodes for EMG monitoring
- AstroMoWe - Innovative Wearable Muscle and Movement Monitoring System for Astronauts
- This revolutionary Czech technology is designed to monitor the movement and muscle activity (EMG) of astronauts on the ISS, combining advancements in miniaturized electronics, e-textiles, and AI.



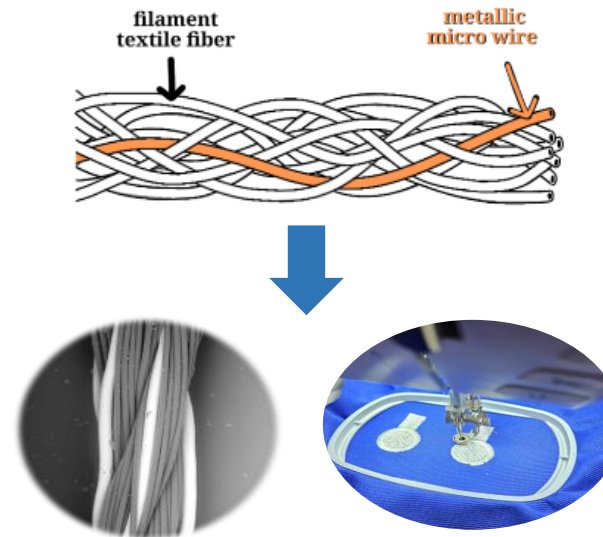
FEL UWB SPACE PROJECTS AND EXPERIENCE

Core Properties

- Long-term EMG sensing with high user comfort
- Precision during dynamic movement in microgravity
- Hybrid conductive fibers (gold-plated molybdenum microwires + aramid fibers)
- Durable, washable, and mechanically robust
- Electrodes secured against displacement

Manufacturing and Integration

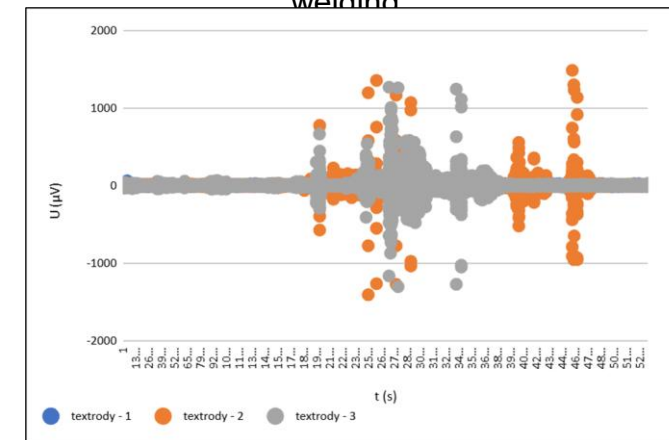
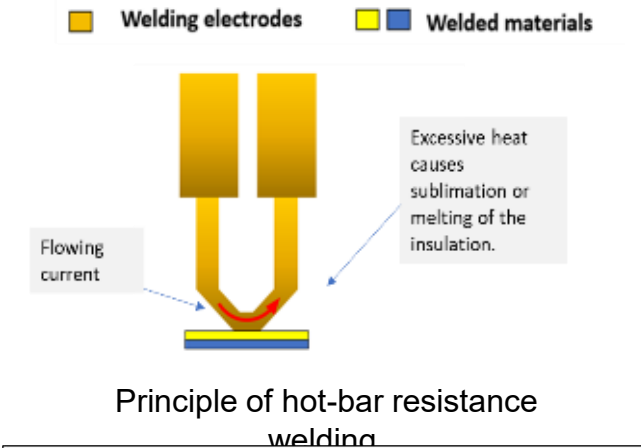
- Automated embroidery for high-precision electrode production
- Integrated into elastic textile sleeves for limbs
- Connection via conductive textile ribbons
- Joining methods: Hot-bar welding



Hybrid conductive thread consisting of conductive microwires and meta-aramid fibers, used for embroidering EMG electrodes.



Embroidered textile electrodes hot-bar welded to a conductive elastic ribbon for EMG monitoring



Preliminary functional testing (EMG monitoring) of the biceps was performed on the tested samples

FEL UWB SPACE PROJECTS AND EXPERIENCE

FITPIX Lite – Compact Timepix-based particle detector

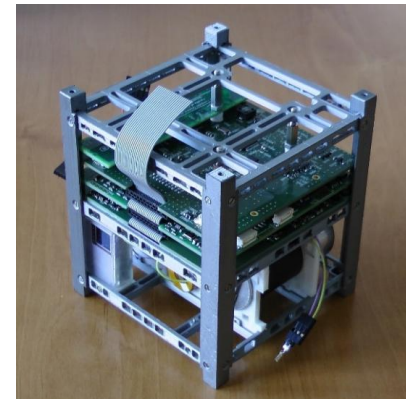
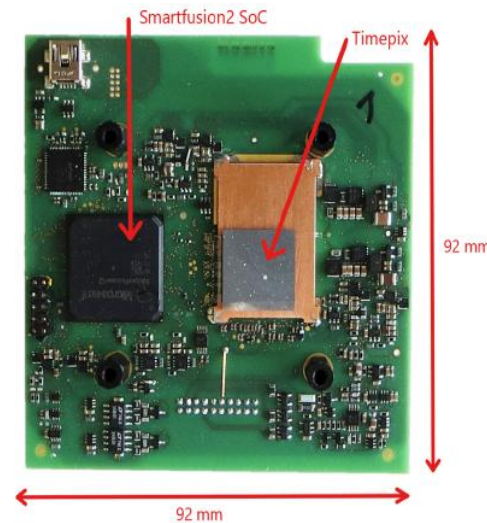
- Candidate device for Radiation Environment Monitors(REM) aboard the International Space Station (ISS)
- Project lead: University of Houston, NASA

Ground segment as a service

- Project lead: Huld s.r.o.
- ESA Call: Framework Project Implementing ESA's Support of Space-Related Activities in the Czech Republic

Student project - Pilsen CubeSat

- Internal student satellite project focused on radiation monitoring
- Onboard data processing
- Dual Timepix detector payload



FEL UWB SPACE PROJECTS AND EXPERIENCE

Electrical design for space applications

- Cooperation with 5M company
- PCB design

UWB FEL COOPERATION AND TECHNICAL READINESS FOR SPACE



JOINT FUNDED
PROJECTS



DIRECT
COOPERATION



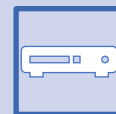
Material Research



Testing and Diagnostics



Modelling and computation



Electronics

Thank you for your attention

University of West Bohemia
Faculty of Electrical Engineering

t: +420 377 634 520

e: pihera@fel.zcu.cz

a: Univerzitni 26, 306 14 Pilsen, Czech Republic

w: fel.zcu.cz, www.fel.zcu.cz/cs/Research/

 Faculty of Electrical Engineering

 [fee_uwb](#)

 Faculty of Electrical Engineering
UWB | RICE

 Fakulta elektrotechnická ZČU



RICE



MATERIAL RESEARCH

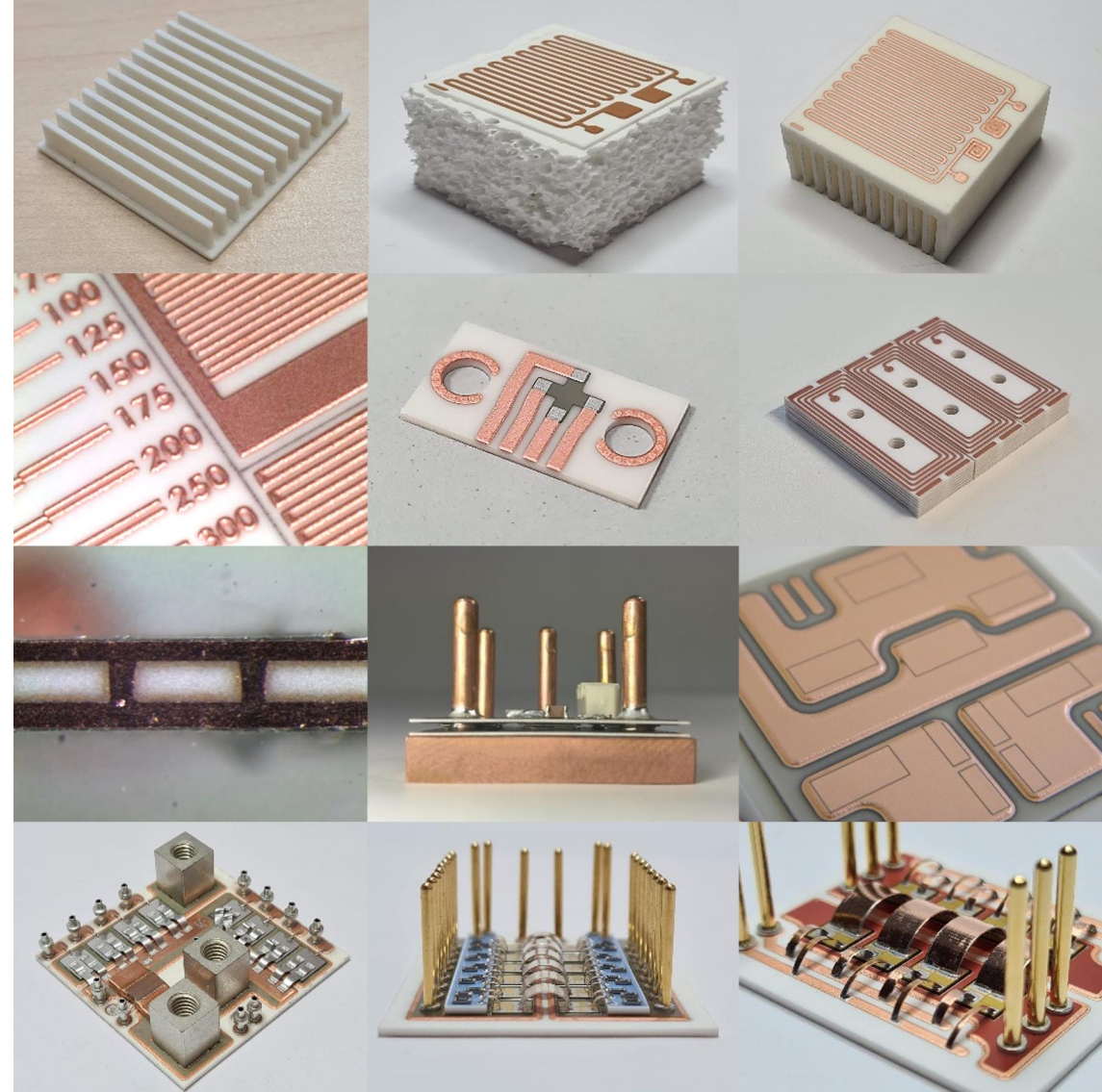
TECHNOLOGY FOR POWER AND HIGH TEMPERATURE ELECTRONICS

High durable and temperature resistant electronic modules based on:

- Alumina (Al_2O_3)
- Spinel (MgAl_2O_4)
- Zirconia (ZrO_2)
- Ceramic foams
- AlN and Si_3N_4
- 3D printed ceramics

Ag and Cu metallization of ceramics by selective printing:

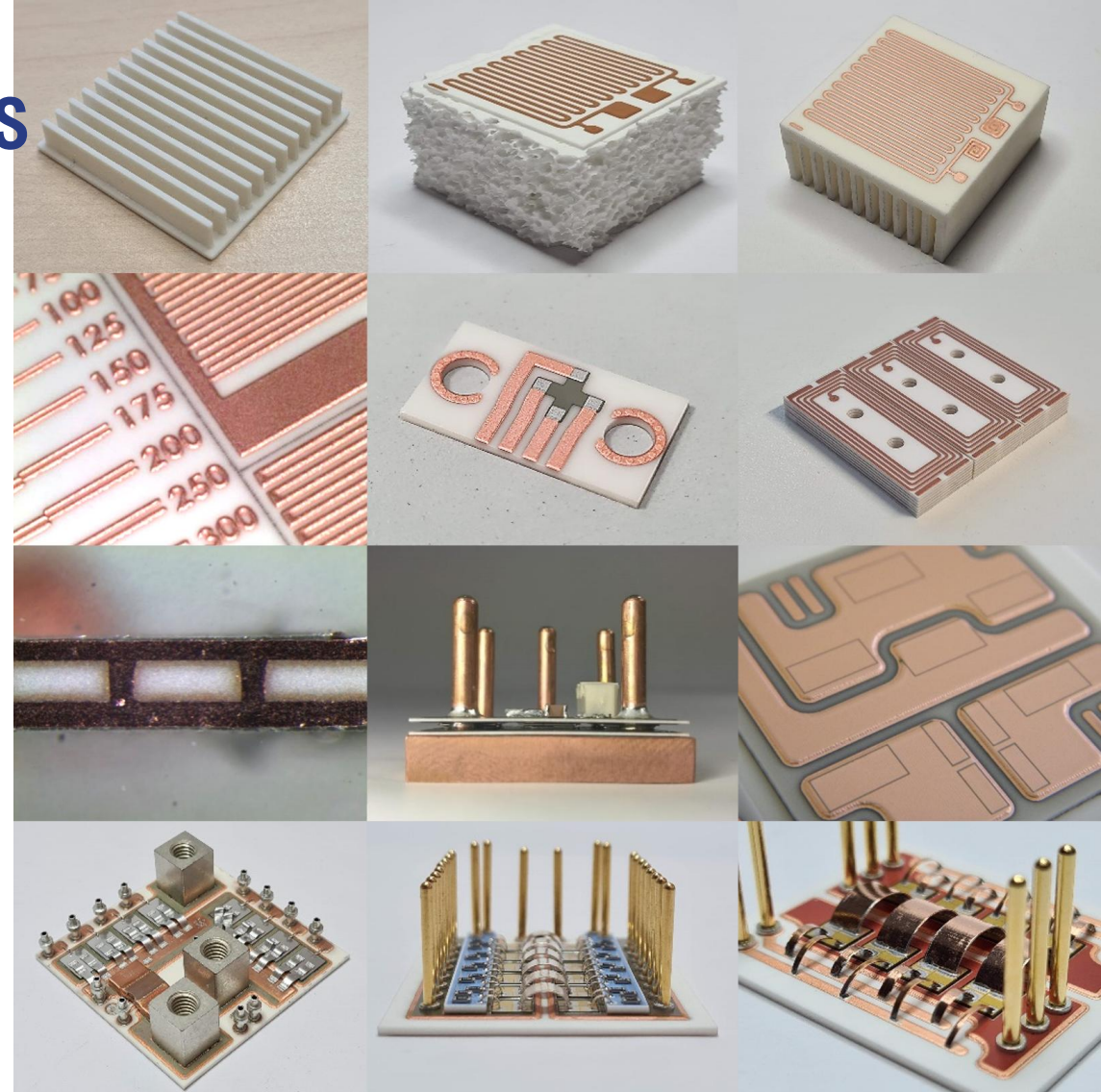
- Fully additive manufacturing process – material savings
- Higher pattern resolution (down to 100 μm line/gap)
- Different thickness of metallization on substrate (from 25 μm to 300 μm)
- High adhesion ($> 40 \text{ N/mm}^2$)
- Direct integration of passive component and sensors
- Assembly of fine pitch SMD components and chips



COMPETENCE: TECHNOLOGY FOR POWER AND HIGH TEMP. ELECTRONICS

Technological benefits and options:

- Multilayer and stacking capability
- Metal plated and filled vias
- High resistance against temperature shock cycling, high temperatures and neutron flux
- Direct integration of electronics to ceramic heat sinks
- 3D printed ceramic packaging



COMPETENCES AND EQUIPMENT FOR HIGH TEMPERATURE ELECTRONICS

Based on TPC technology (Thick Printed Copper)

- Thick film technology development and optimization
- Additive deposition of materials on ceramics, 3D printing of ceramics
- High temperature electronic substrates R&D (components for fusion reactors, CPV and power modules)
- New bonding and interconnection technologies R&D
- Power modules diagnostics and testing

Production and diagnostic equipment:

- Thermosonic bonding, Resistive spot micro-welding and sintering
- High temperature furnaces (with gas-tight retort)
- Vacuum reflow furnace in combination with formic acid vapours



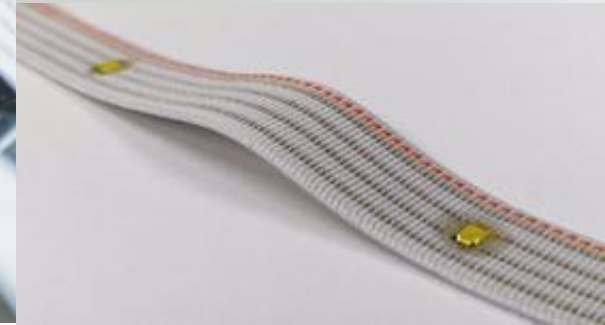
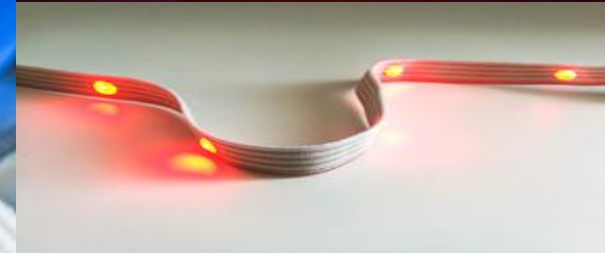
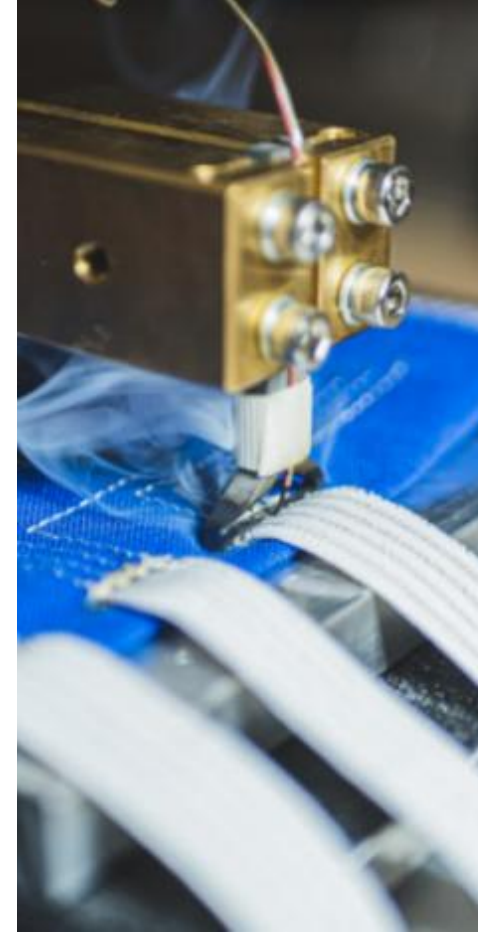
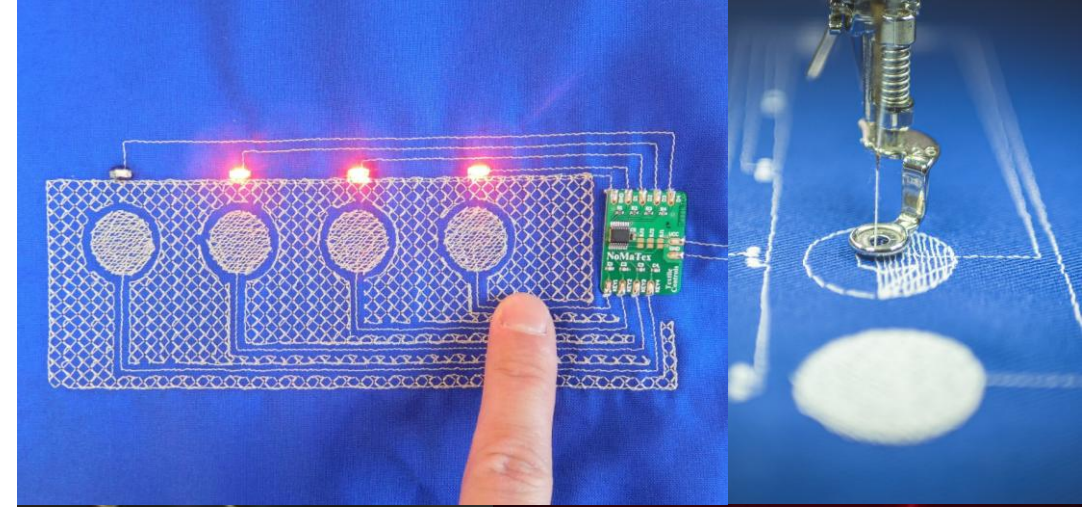
DEVELOPMENT OF E-TEXTILES

Interconnection systems

- Hybrid conductive threads containing ultra-fine metal wires combined with synthetic fibres.
- Innovative textile conductive ribbons

Linking, integration and encapsulation

- Technology of interconnection of conductive textiles based on ultrasonic plastics, resistance welding, thermocompression welding
- New thermal compression method for direct integration and encapsulation of SMD components or modules on a textile substrate or ribbons



DEVELOPMENT OF E-TEXTILES

Textile sensors and electrodes

- Fully textile thermocouple sensors, large area temperature sensors, pressure, tension, humidity, presence, proximity, respiratory rate and skin hydration sensors
- Textile electrodes - ECG monitoring, EMS stimulation
- Heated textiles with integrated occupancy and temperature sensors

Textile antennas

- Textile dipole and bow-tie antennas
- Textile sensor antennas for monitoring edema, respiratory rate



APPLICATIONS OF E-TEXTILES

Protective clothing and personal protective equipment:

- Smart protective suit and gloves with integrated sensor system
- Shoe with an integrated inertial localization system

Home and healthcare

- Smart sheet including evaluation electronics for patient monitoring (integrated occupancy, motion, and humidity sensors in 2 zones)
- Compression leg sleeve - for effective compression therapy of tibial ulcers.

Heating fabrics, IoT elements

- Knitted heating fabric with high resistance to washing cycles also with integrated presence sensors
- Printed and embroidered antennas for IoT applications and knitted sensor antennas.



PRINTED ELECTRONICS

Technology

- Aerosol Jet Printing, Dispensing, Screen Printing

Printed functional elements

- Passive (R, L, C,) active (OECT), antennas), sensors (T, RH, chemical)

Systems-on-Foil

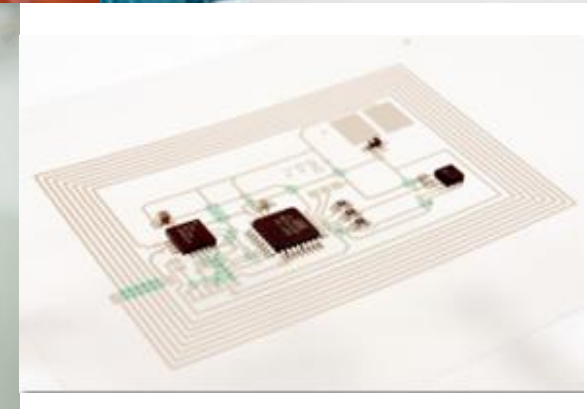
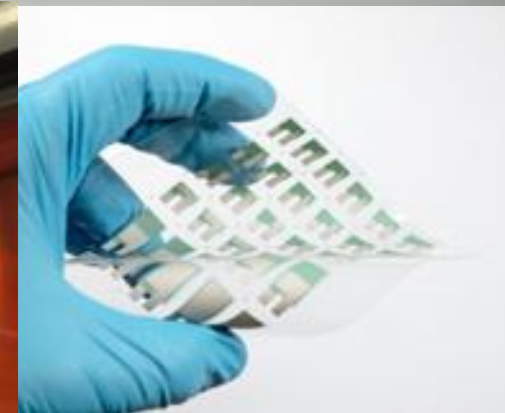
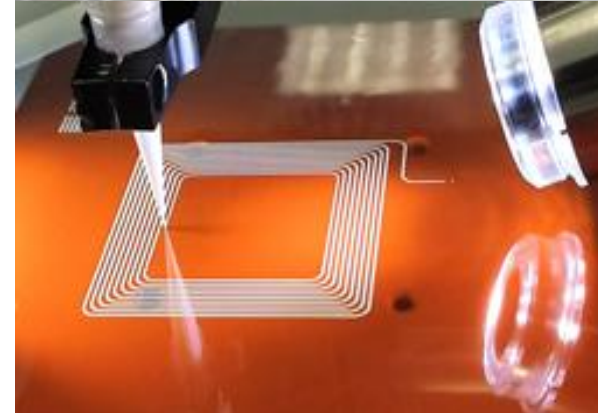
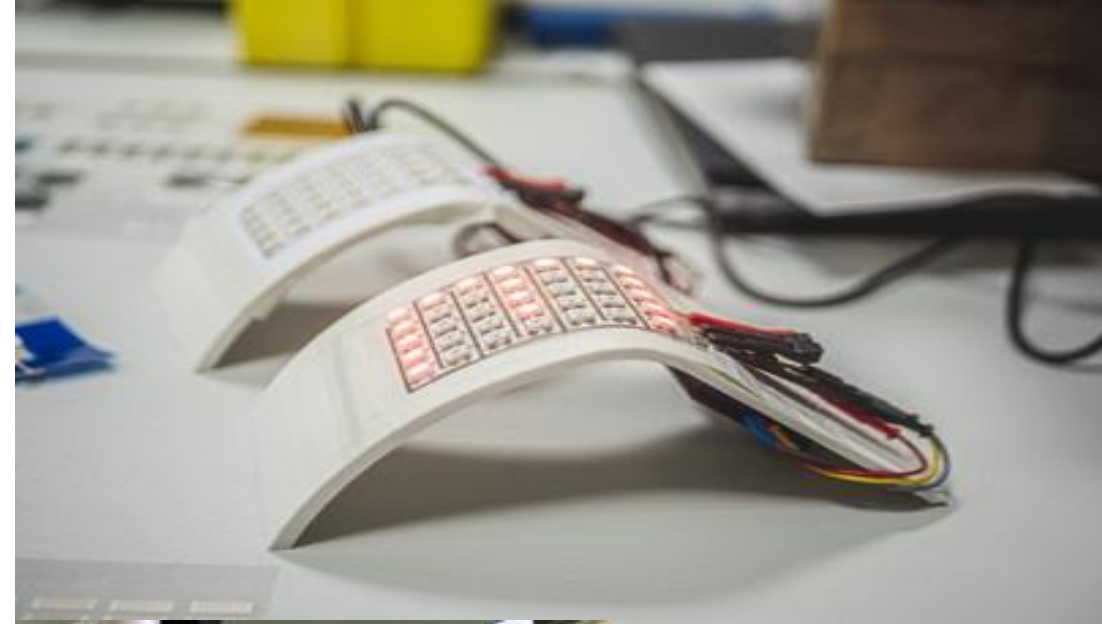
- Hybrid SMT assembly on printed interconnect structures
- Printed flexible labels for T+RH (Smart labels) monitoring

Flexible electronics

- Soft and flexible substrates, elastic conductive motifs
- Multi-material strain-relief interface rigid-flex-stretch
- Applications in E-textiles (direct printing, transfer)
- Combination of textile conductive elements (bus bars, electrodes) and printed elastic structures

Thermoformable electronics

- 3D electronics on thermoformable polymer carriers



Sensors

Research and development of printed and textile sensors for IoT applications

Chemical sensors

- Chemoresistive (ammonia, humidity)
- Electrochemical (Nitrogen oxide, ethylene)

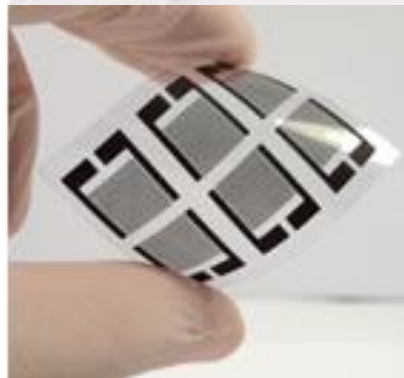
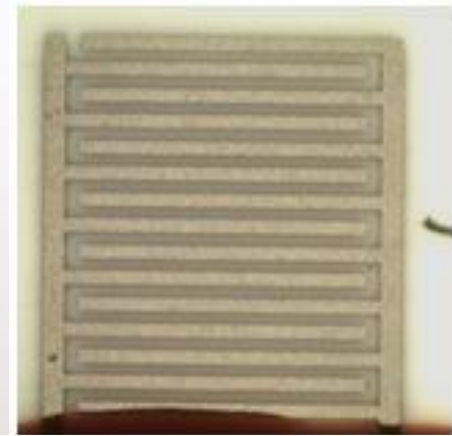
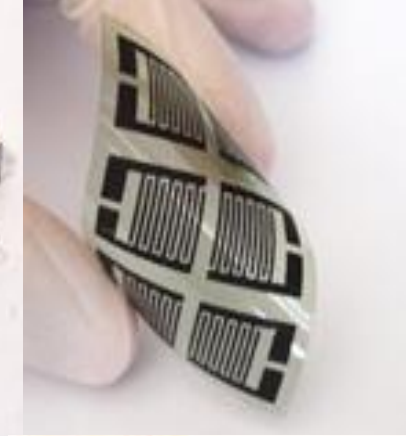
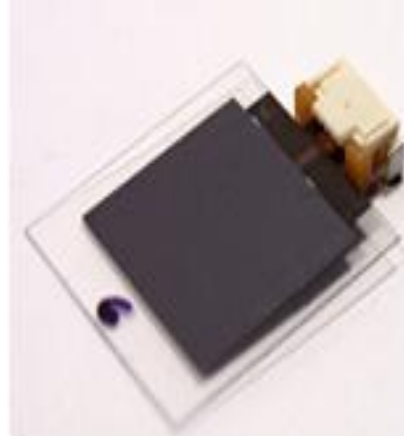
Physical sensors

- Resistive
- Capacitive

Additive manufacturing based on organic materials and nanomaterials

Planar flexible sensors

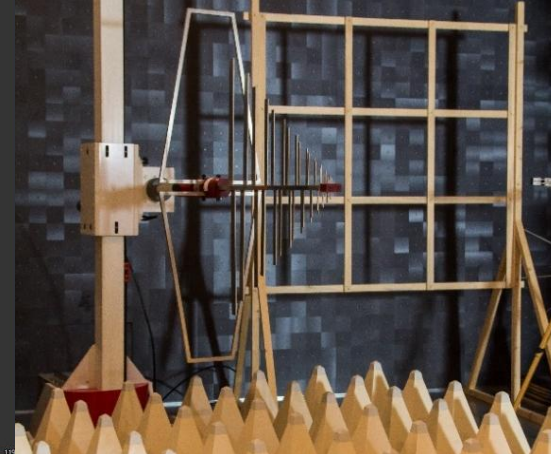
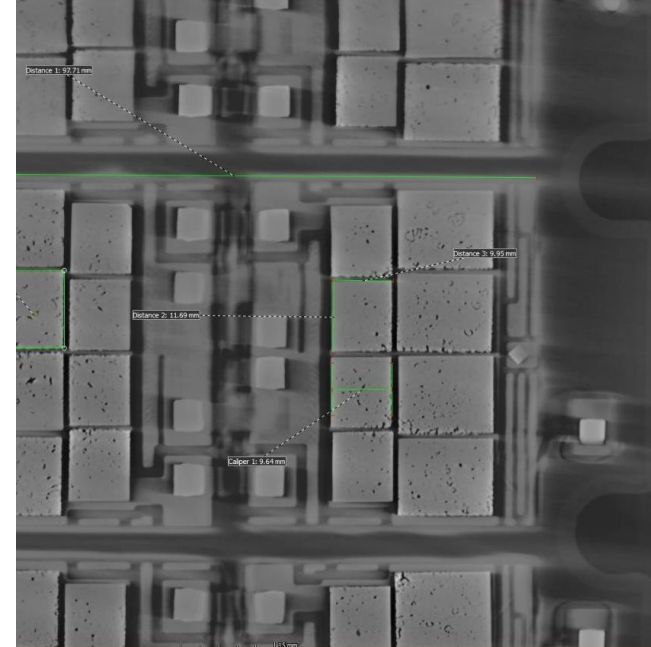
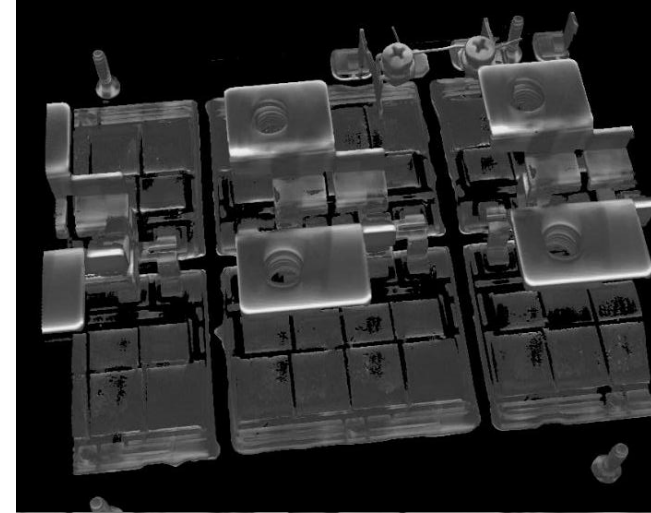
- suitable for integration into flexible electronic systems (smart labels and packaging, film systems, embedded sensors), Embroidered textile sensor, Embroidered textile sensor



DIAGNOSTICS AND TESTING

SELECTED DIAGNOSTICS AND TESTING INFRASTRUCTURE

- Clean rooms, X-Ray diagnostics and 3D tomography
- Diagnostics of materials and structural analysis (including TGA, DMA, TMA, FT-IR)
- Environmental testing, NVH testing (humidity, temperature or aggressive gases)
- Microscopy laboratories
- Electromagnetic compatibility (EMC) laboratories
- Electrical laboratories (EL)
- A certified testing laboratory (no. 1090)



DIAGNOSTICS & TESTING

Materials diagnostics and structural analysis

Electrical testing

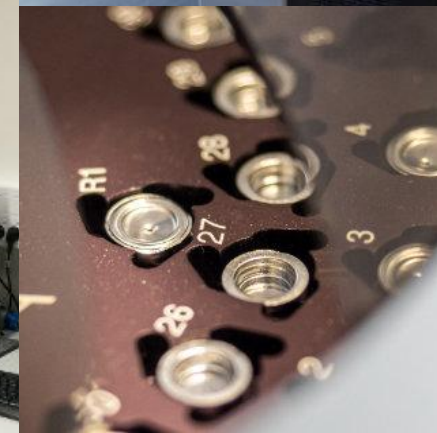
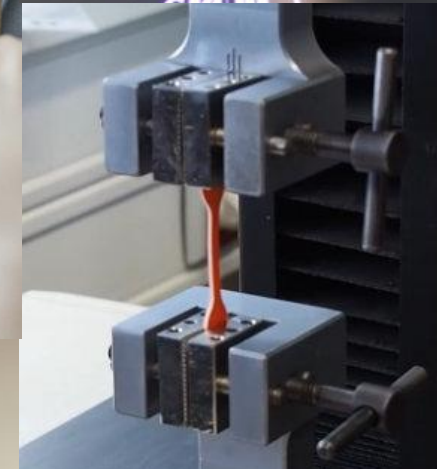
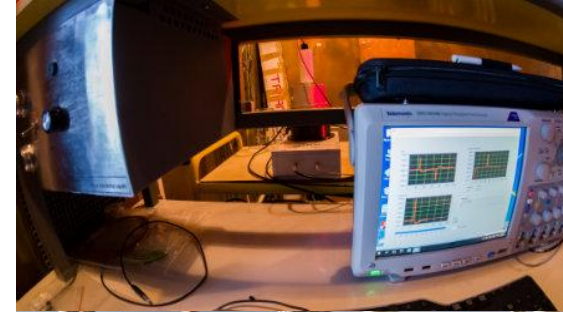
- Monitoring of dissipation factor, permittivity, dielectric strength, partial discharges, insulation resistance, volume or surface resistivity, and other electrical parameters.
- Space charge diagnostics (newly added).

Structural testing

- Equipped with thermal analysis techniques such as DSC, STA, TMA, and DMA.
- Infrared spectroscopy with Fourier transformation.

Mechanical testing

- Static tensile, compression, and bending tests at normal and elevated temperatures.
- Bending impact tests for metallic and non-metallic materials.
- Hardness measurements of plastics based on Shore A and Shore D methodologies (ISO 868, ASTM D2240).



DIAGNOSTICS & TESTING

Diagnostics of environmental influences

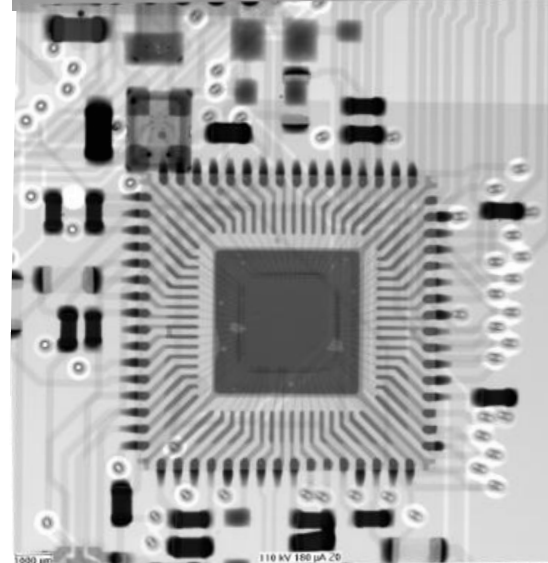
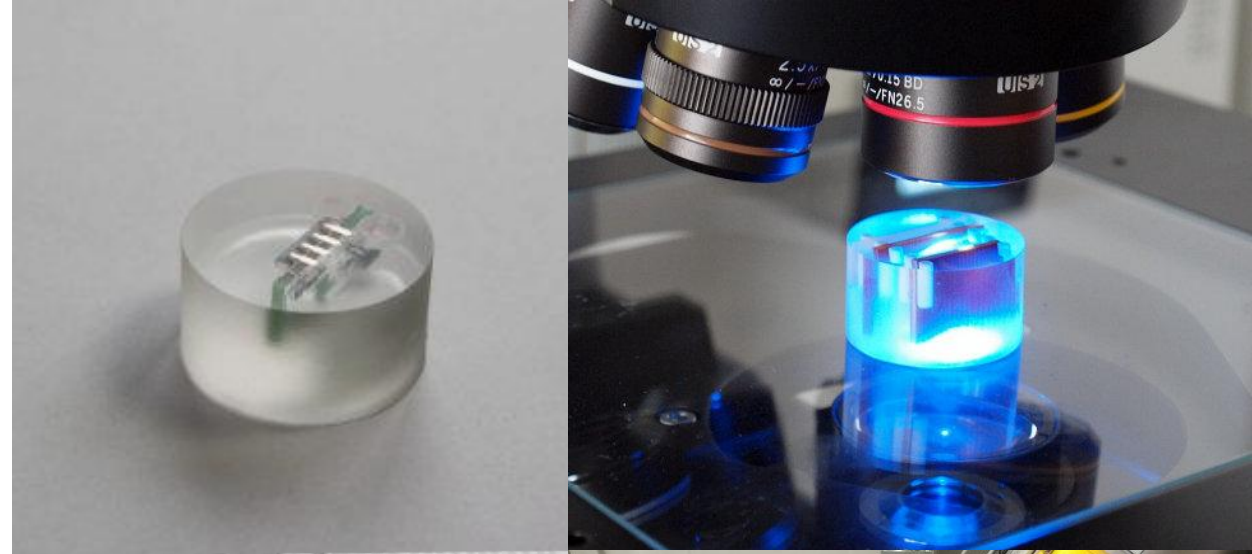
- Climatic chamber with a volume of 180 liters for simulating temperatures from -70 °C to 180 °C and relative humidity from 10% to 98% RH.
- Shock climatic chamber for rapid temperature changes between -80 °C and 220 °C.
- Chamber for corrosion testing and tests for the influence of harmful emissions (Cl₂, SO₂, NOX, H₂S).
- Material solderability and lifespan tests, including combined aging of insulators with pulsed (± 5 kV) voltage and temperatures up to 300 °C.
- Simulation of various conditions, including humidity, temperature, and vibrations.



DIAGNOSTICS & TESTING

Microscopy and tomography diagnostics

- Diagnostics of electronic components, printed circuit boards and interconnection structures.
- Optical microscopes, Laser confocal microscope with the possibility of 3D measurements or the possibility of using the AFM module (atomic force microscope), Electron microscope, Fluorescence microscope.
- Magnifications from 10x - 150 000x.
- Computed tomography v|tome|x (samples max. 250 mm x 400 mm and 10 kg).



DIAGNOSTICS & TESTING

Acoustics

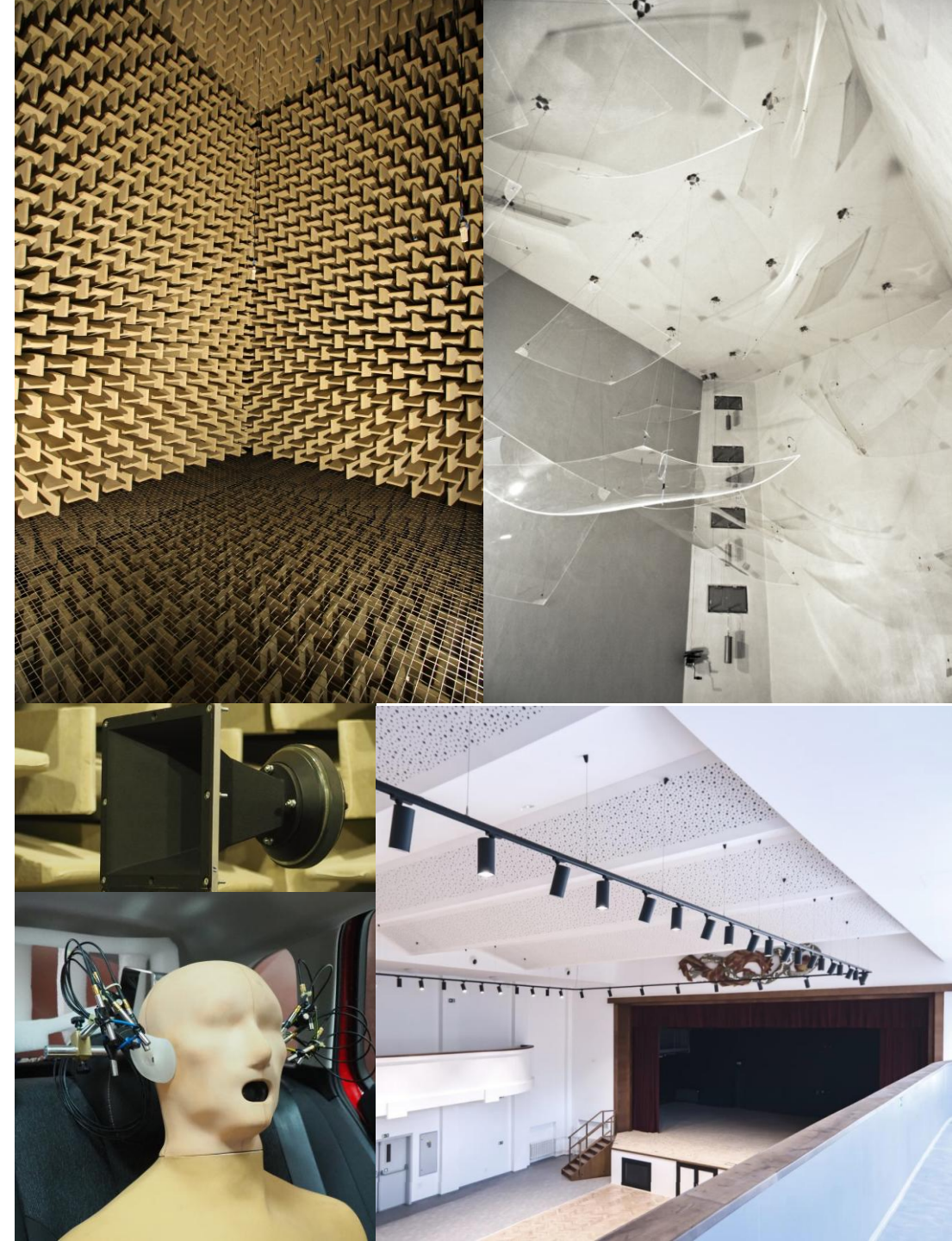
- Noise and vibration parameters measurement.
- Design of special and non-standard acoustic measurement methods.
- Sound source localization.

Electroacoustics

- Parameters of electro-acoustic transducers and other electro-acoustic devices measurement.
- Design and set-up of sound systems.

Room and building acoustics

- Room and building acoustics parameters measurement.
- Room acoustics treatment design.
- Measurement of sound absorption in reverberation room.



DIAGNOSTICS & TESTING

Electromagnetic compatibility

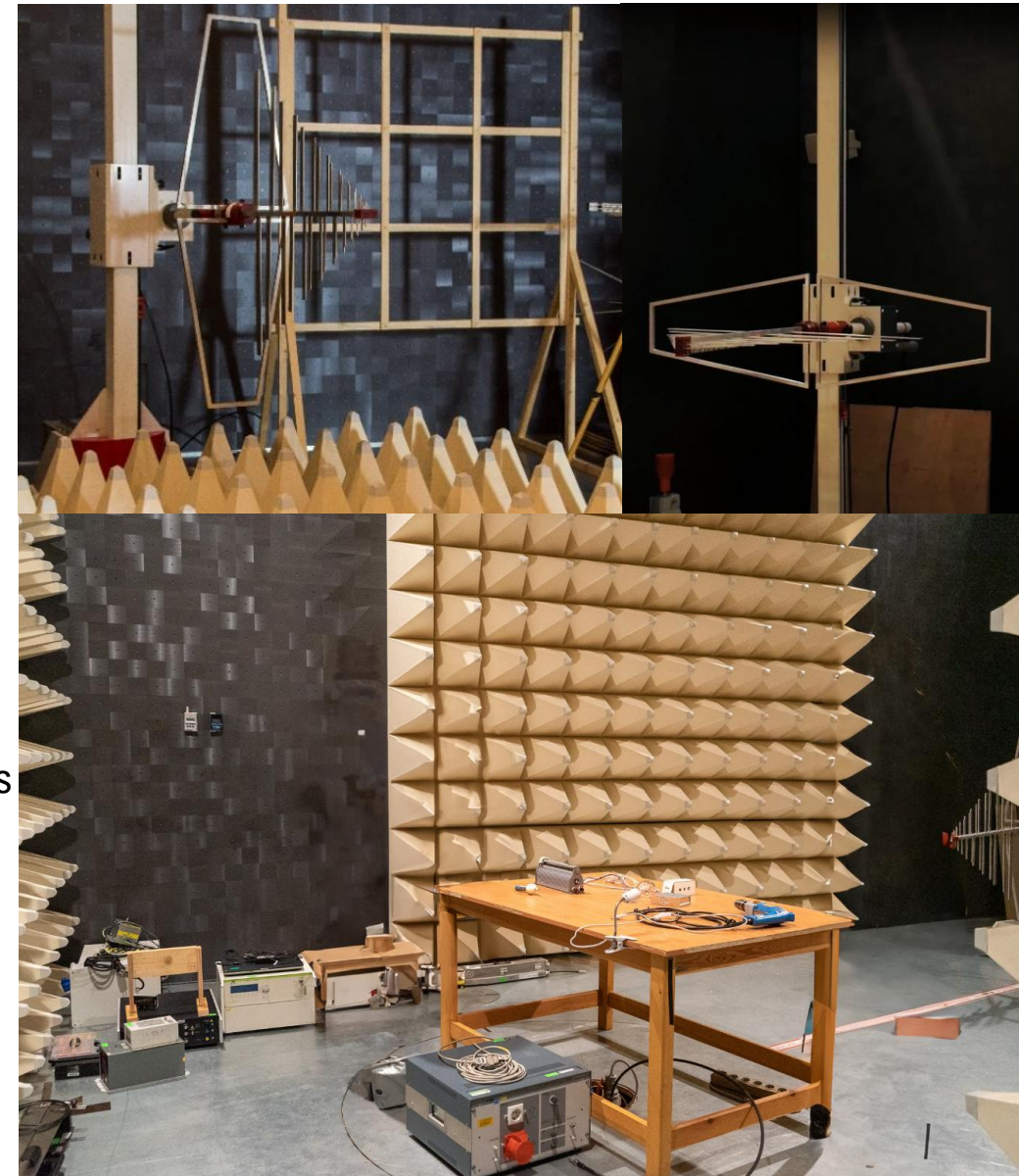
- Diagnostic activities in the field of EMC.
- Interference immunity verification.
- Measurement of electromagnetic interference.

Specializations

- Testing for interference in wires (9 kHz to 30 MHz).
- Resistance to:
 - transient impulse groups
 - radiated interference (9 kHz to 6 GHz)
 - shock waves
 - high-frequency interference through wires
 - high-frequency electromagnetic fields with various modulation types
 - voltage fluctuations and outages
 - static electricity discharges
 - magnetic field and magnetic field pulses

Documentation and Declarations

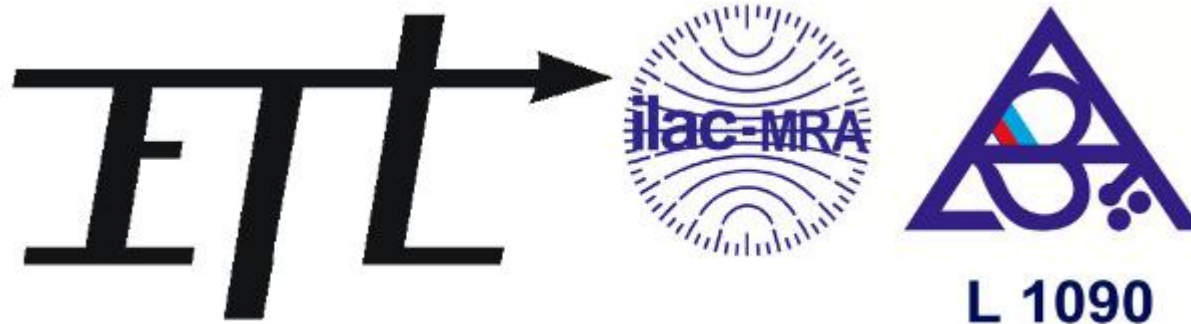
- Preparation of declarations of conformity.
- EC declarations according to NV No. 616/2006 Coll.
- Documentation for compliance with European Directive No. 2004/108/EC for CE declaration.



DIAGNOSTICS & TESTING

Electrical Engineering Laboratory (ETL)

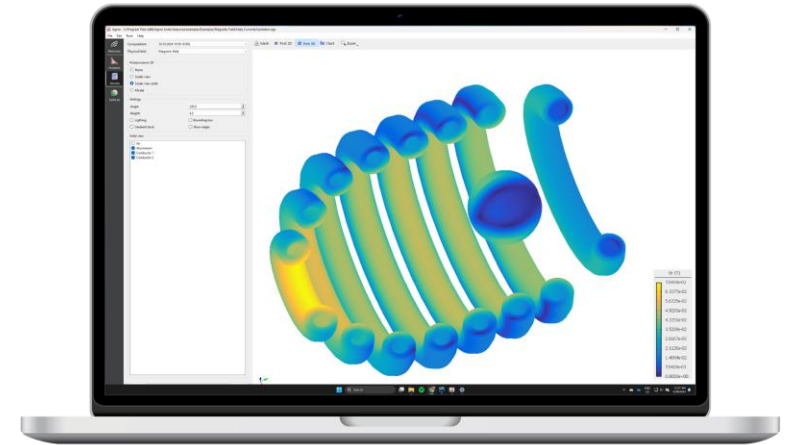
- Accredited Testing Laboratory No. 1090
- Accredited by the Czech Institute for Accreditation according to ČSN EN ISO 17025.



MATHEMATICAL-PHYSICAL MODELLING AND COMPUTATION

Numerical modeling

- Agros - Development of own finite-element software
- Implementation of modern optimization techniques
- Machine learning and AI
- Numerical modeling and computations in several commercial simulation software

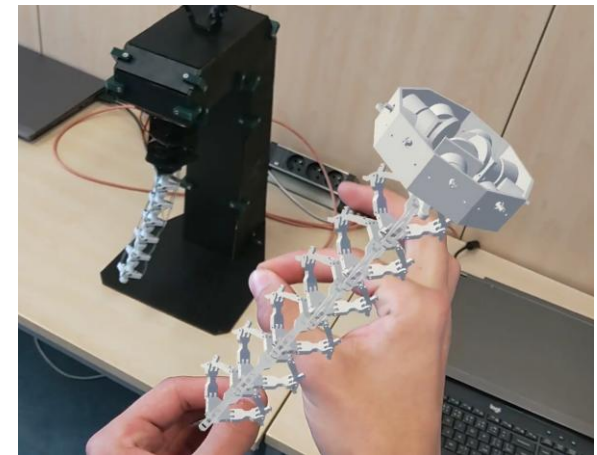


Special robotic systems

- Minirobotics
- Evolution of effectors and soft-robotics tools

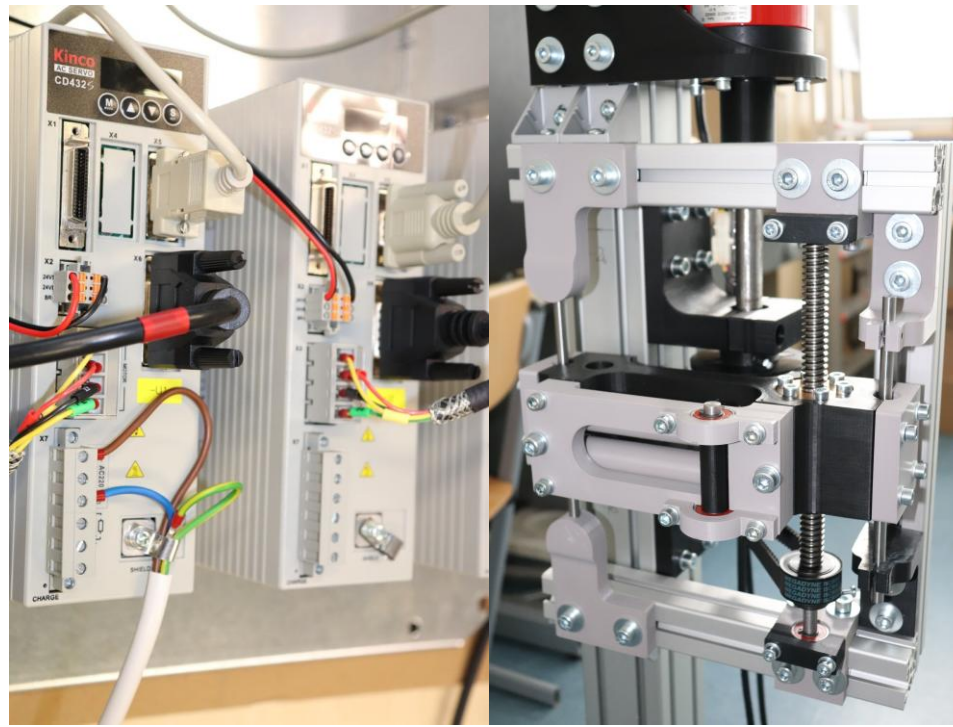
Virtual and mixed reality

- Industrial process monitoring and control
- Data visualisation in real applications
- Visualisation of physical fields



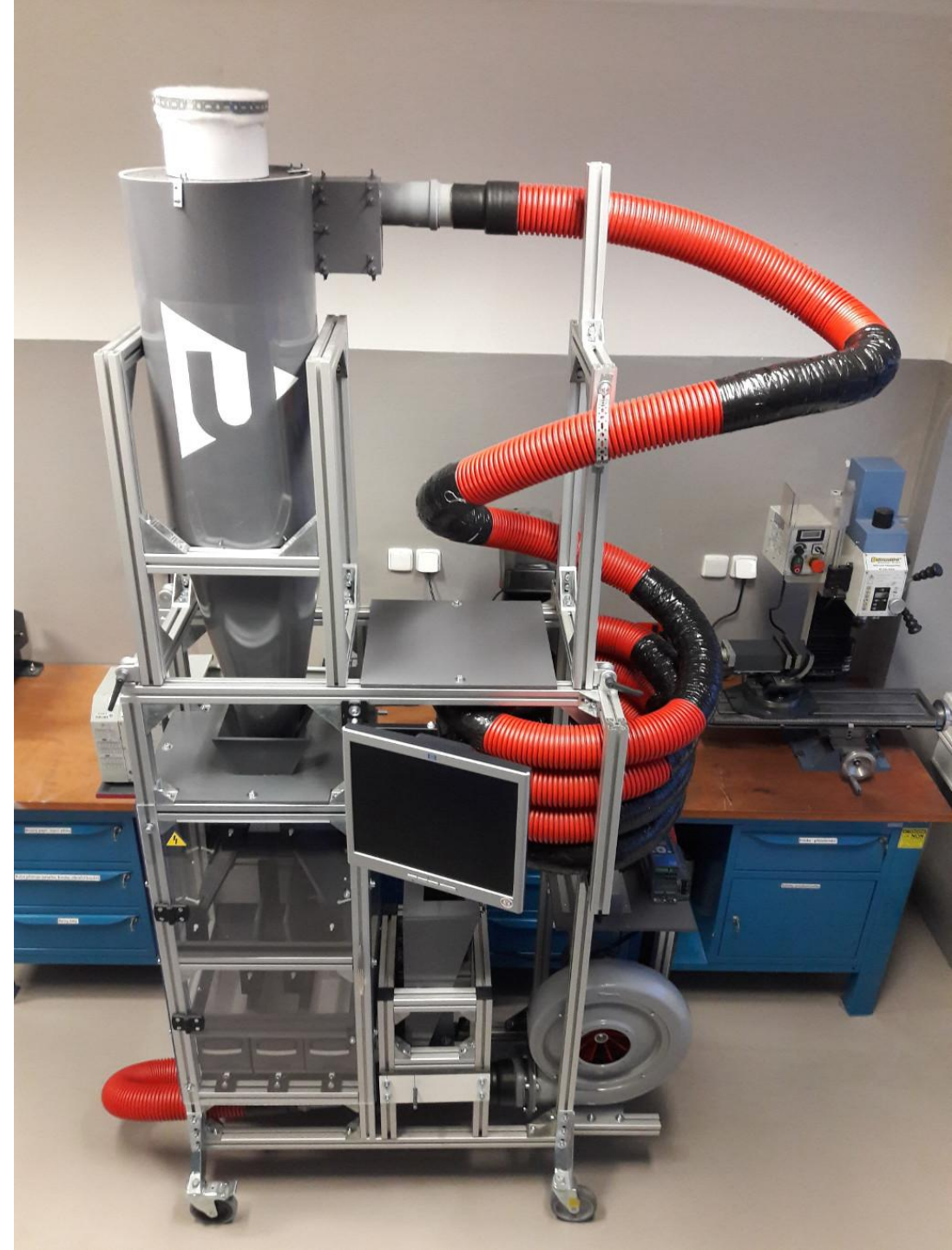
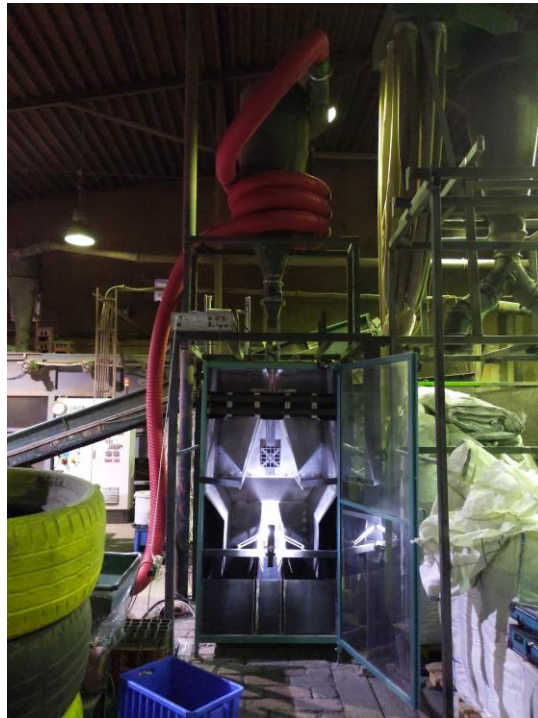
FlyOnVision

- Development of an advanced flight simulator of a paraglider with the support of virtual reality
- glider flight in free space, taking into account atmospheric influences such as weather, daily cycle, or thermal activity



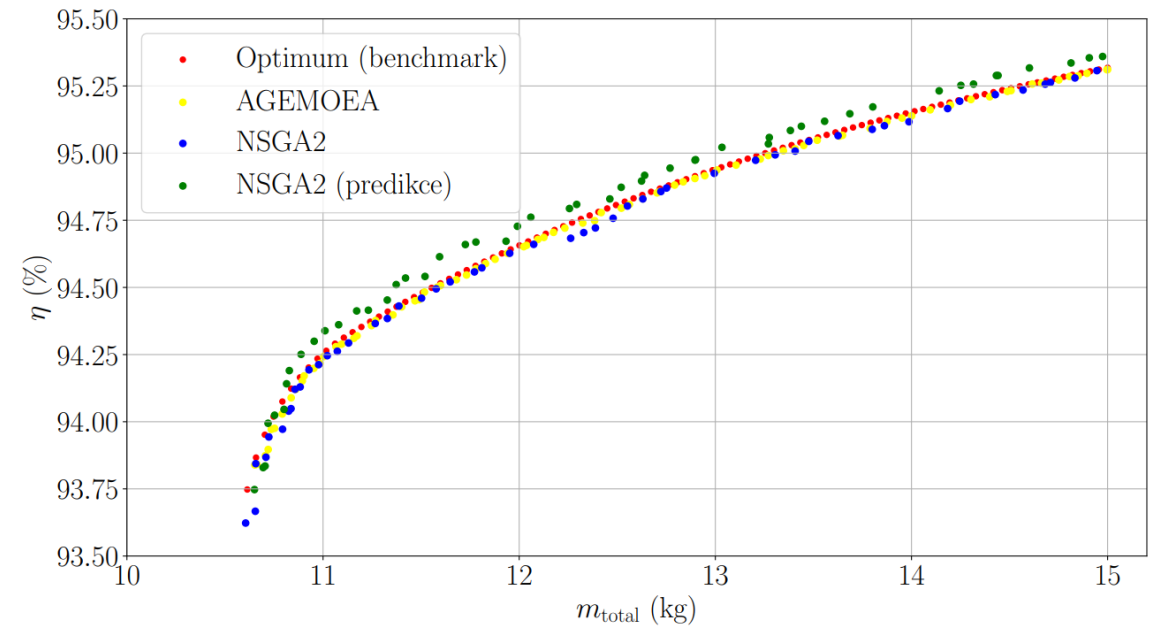
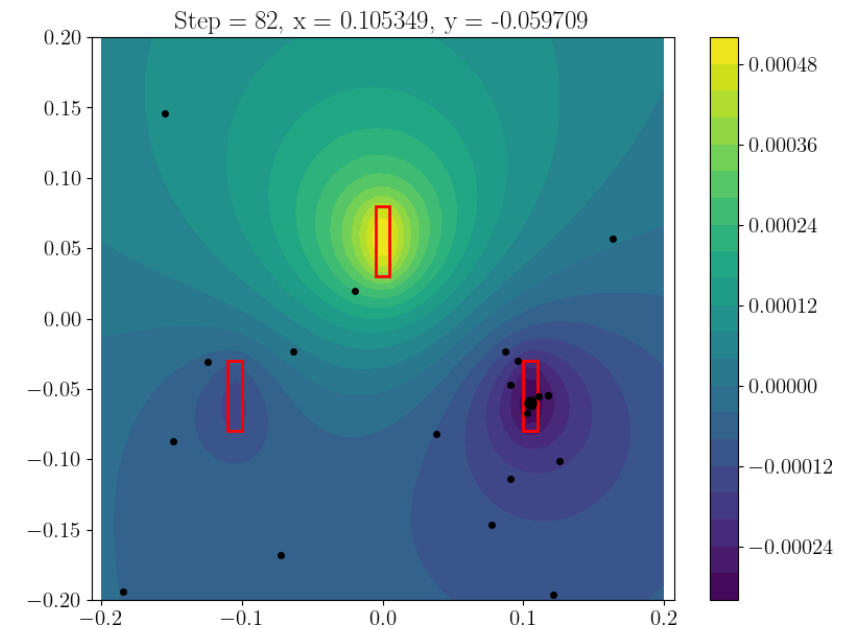
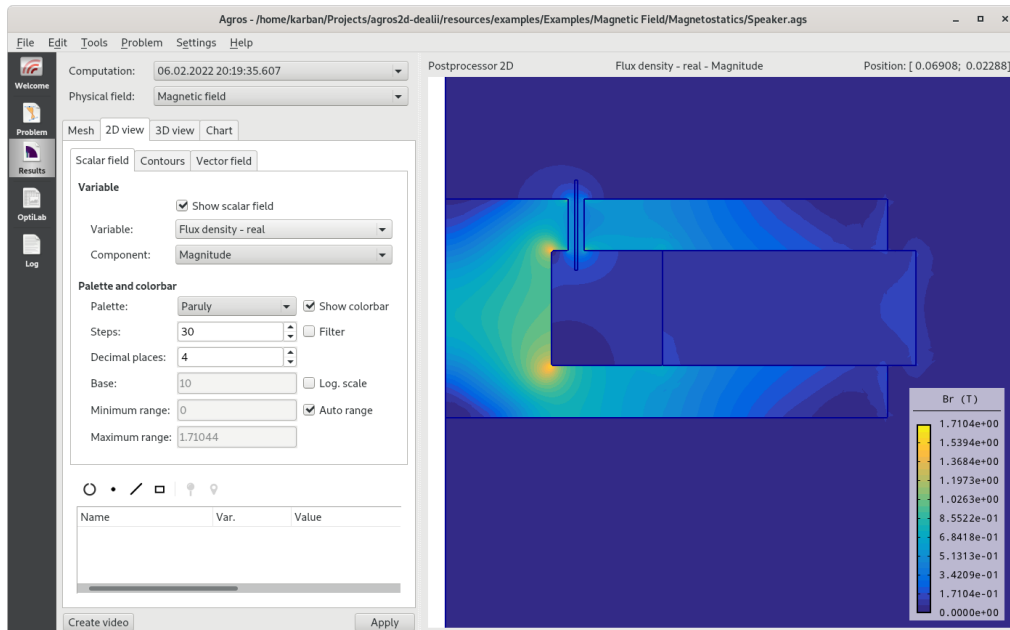
ELECTROSTATIC SEPARATION

- Electrostatic plastic separator that can sort different types of plastics based on different electric charges
- We are still finding new materials suitable for "free-fall" separation
- We modify the separator for testing to suit the companies and the material supplied by them



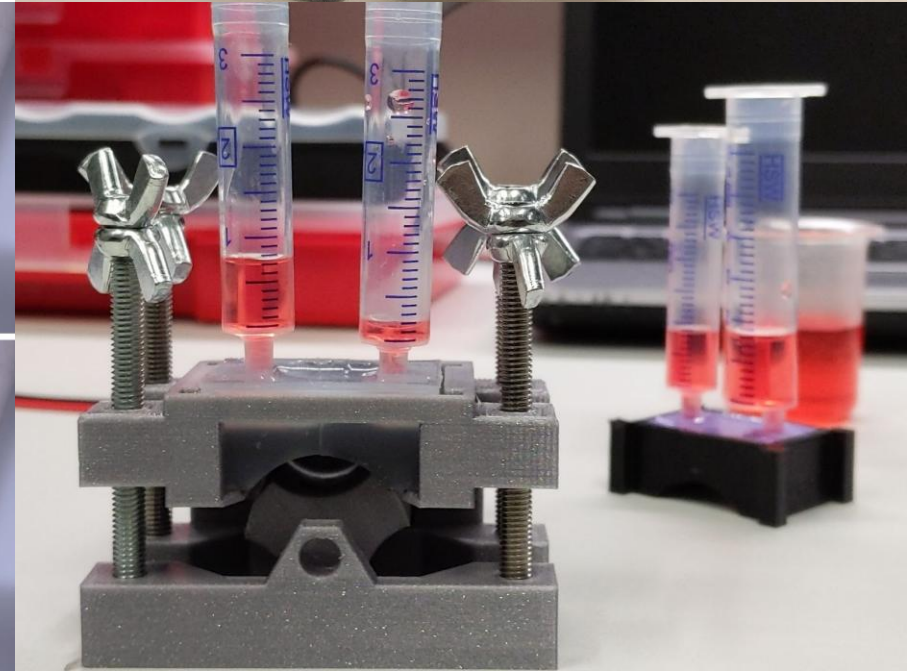
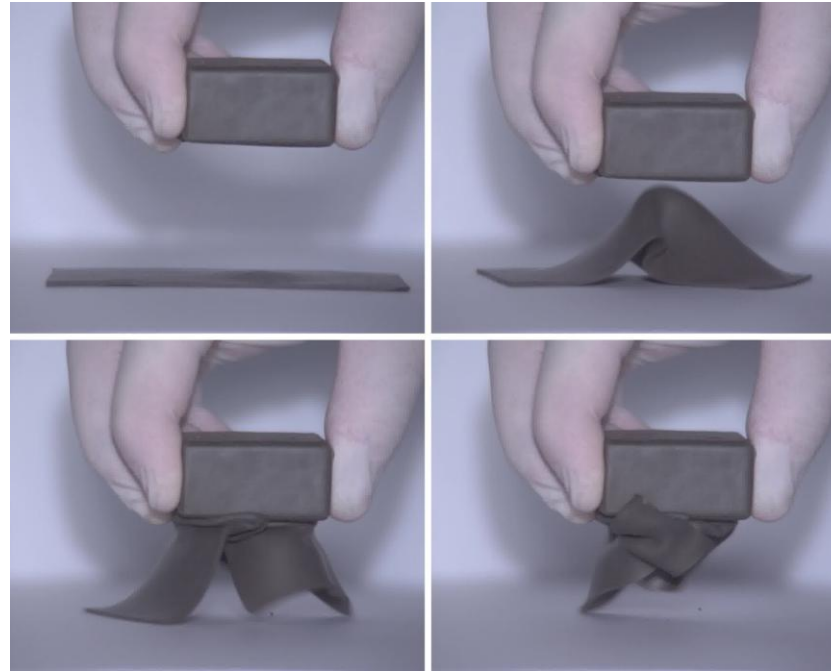
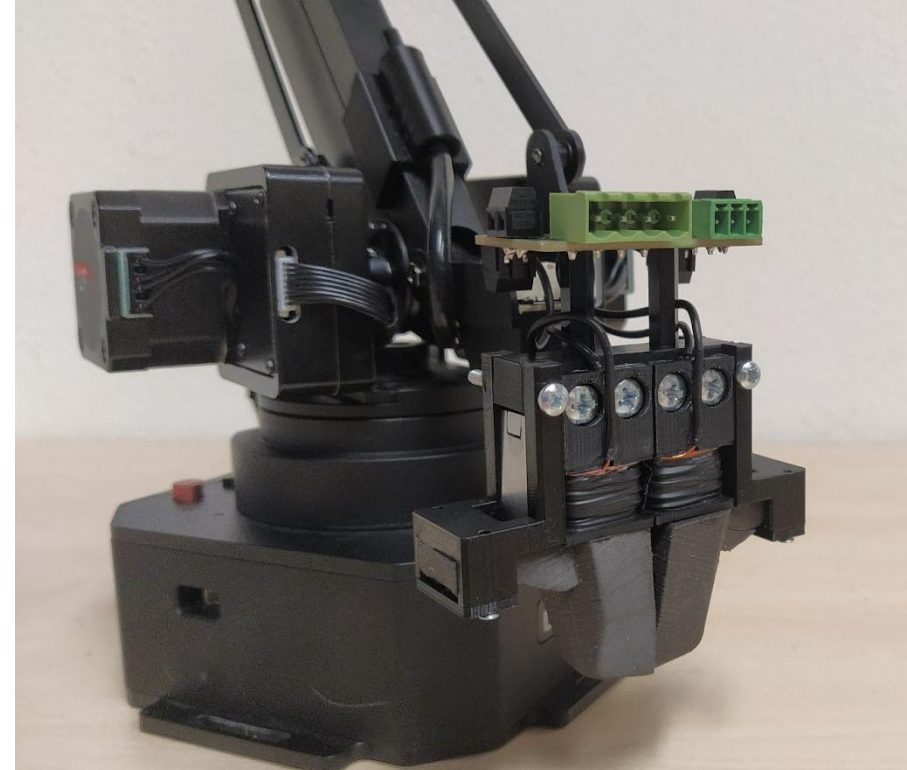
ĀRTAP AND AGROS SUITE

- Own software for robust design of electrical equipment
- computer modeling of physical fields and coupled problems in 2D in a user-friendly graphical environment
- Basic deterministic and stochastic optimization methods



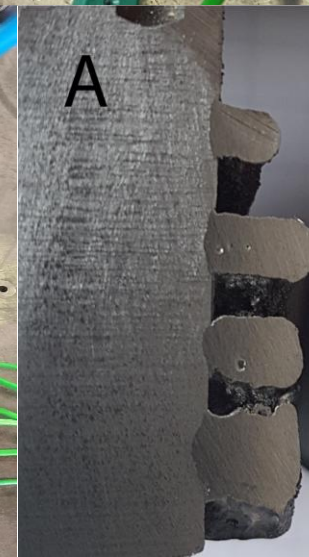
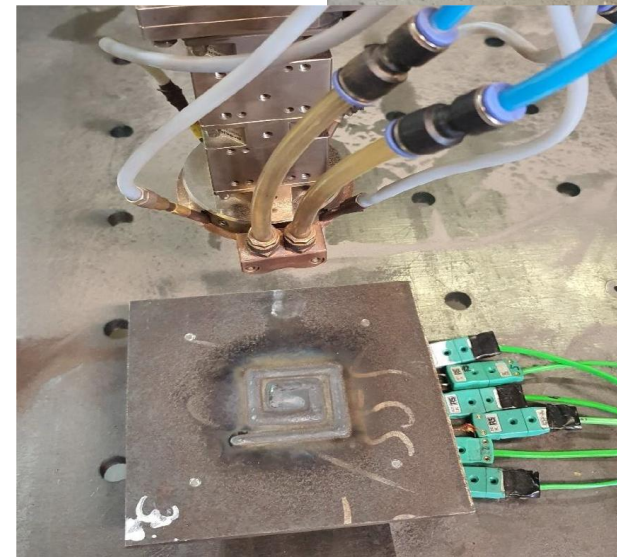
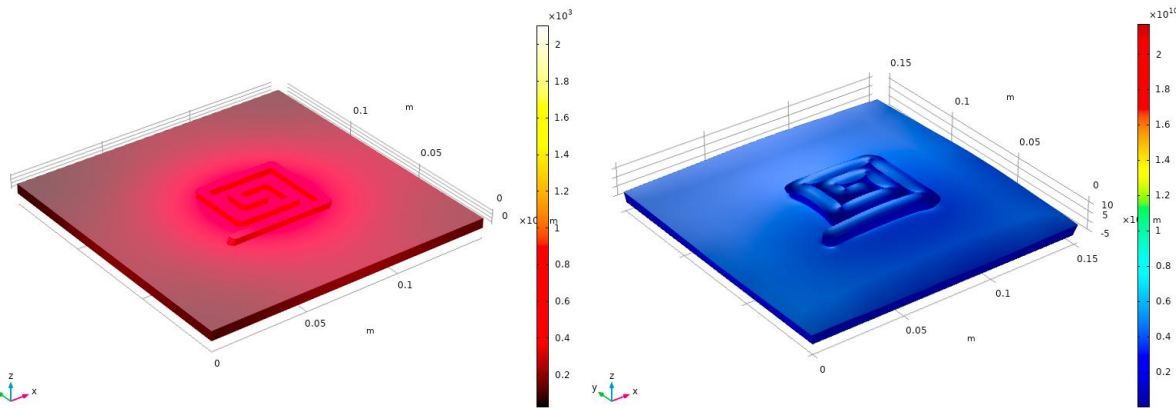
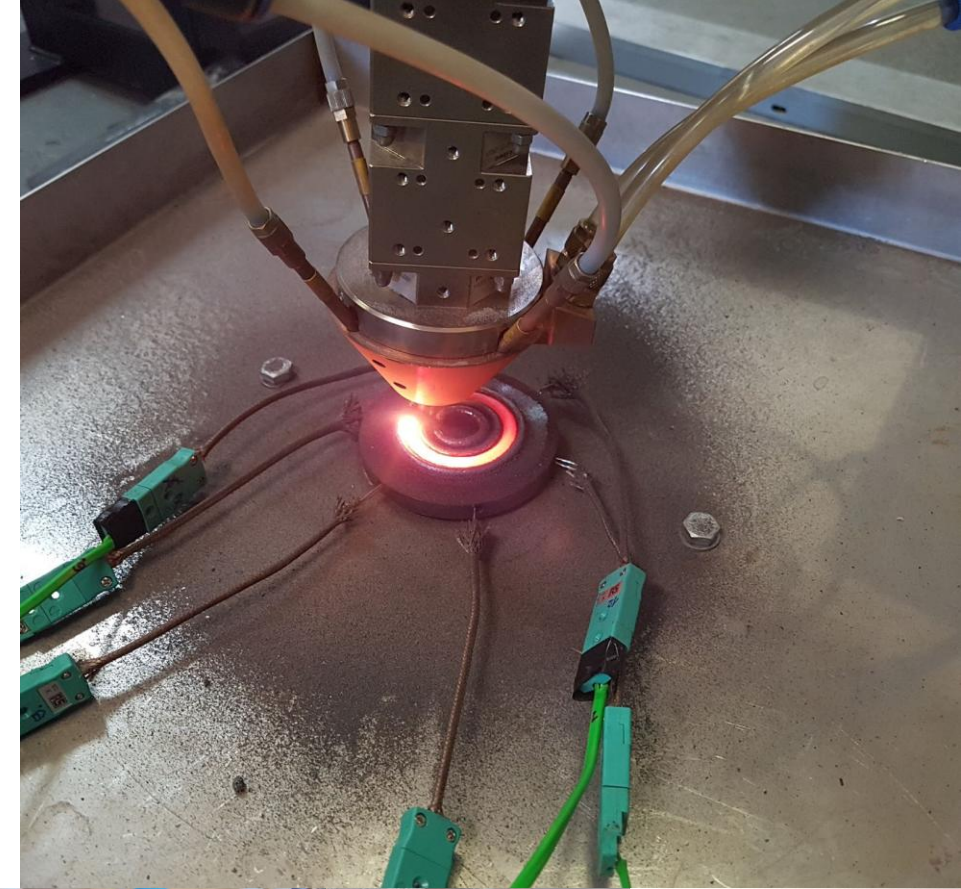
ELASTOMERS

- study of the properties of magnetorheological elastomers (MRE) and the possibilities of their use
- The material is formed by mixing additional silicones with ferromagnetic particles, making it both highly elastic and magnetic
- The application of a material using both properties of the material then makes the concept physically intelligent



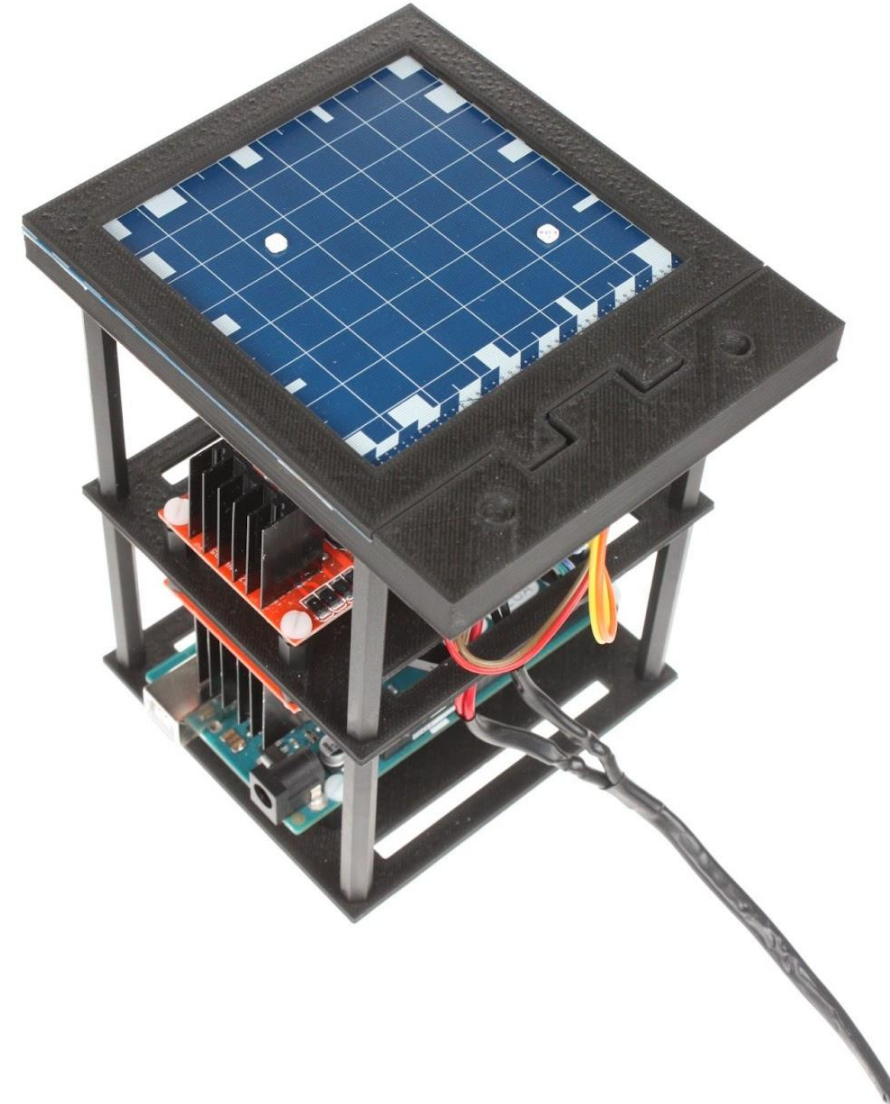
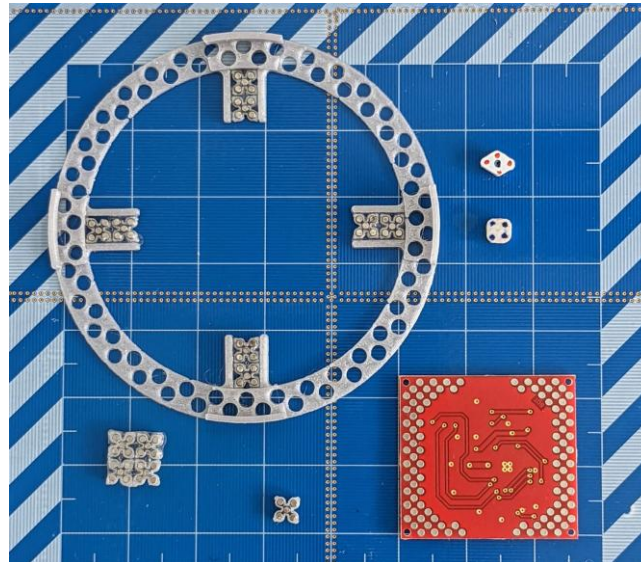
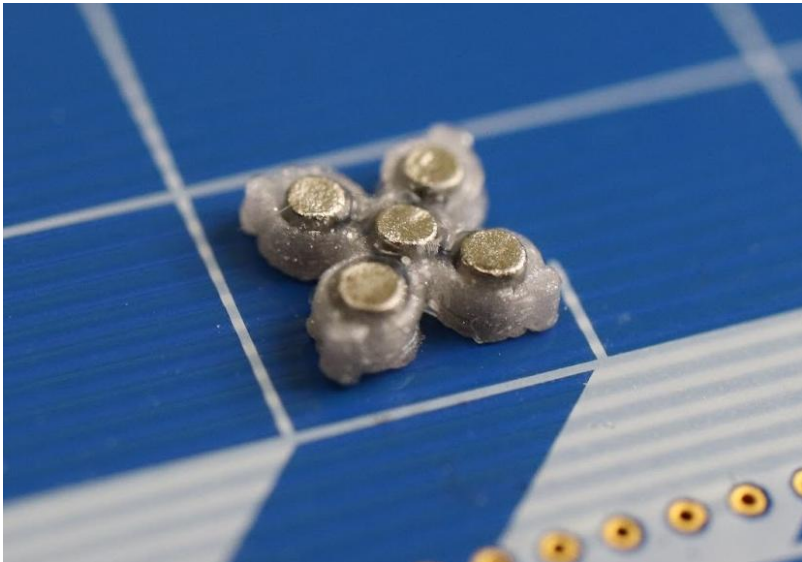
LASER CLADDING

- Development of a 3D printer for metal based on the principle of laser cladding
- Using a numerical model, different properties of overlay stability are tested for a wide range of parameters



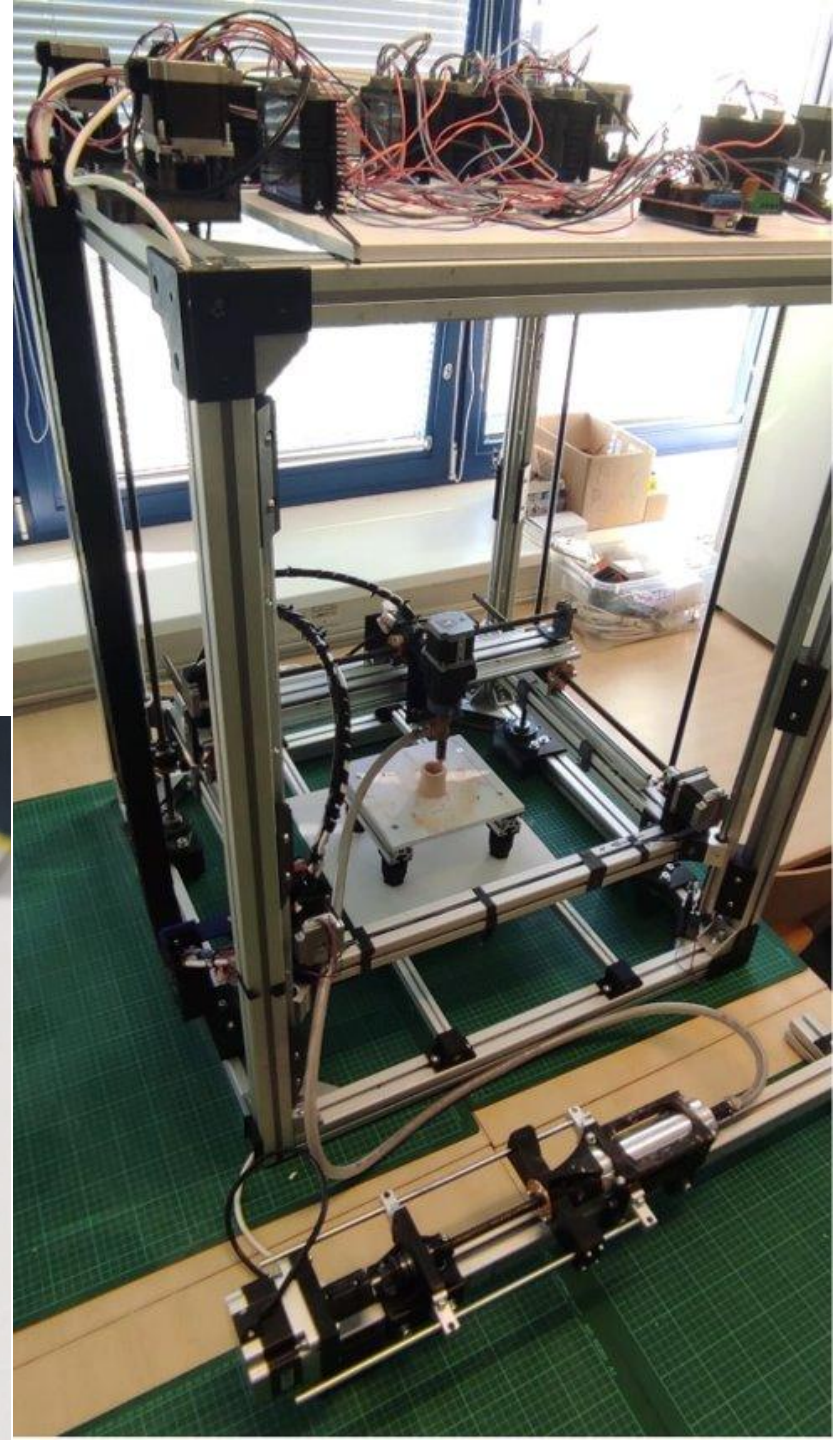
MINIROBOTICS

- Using a system of coils and small magnets, we build small robots that can outperform many animals in terms of their load capacity
- Can carry more than 4000 % of their own weight
- more complex robotic structures that can work together or connect



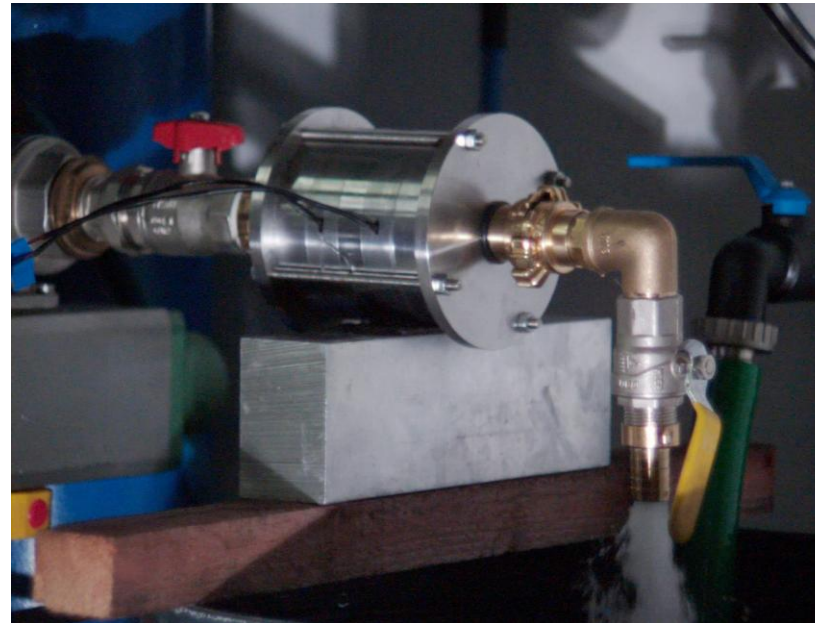
KEPrint

- Universal printing platform with extruder for ceramic materials
- Expandability for additional printheads for other materials



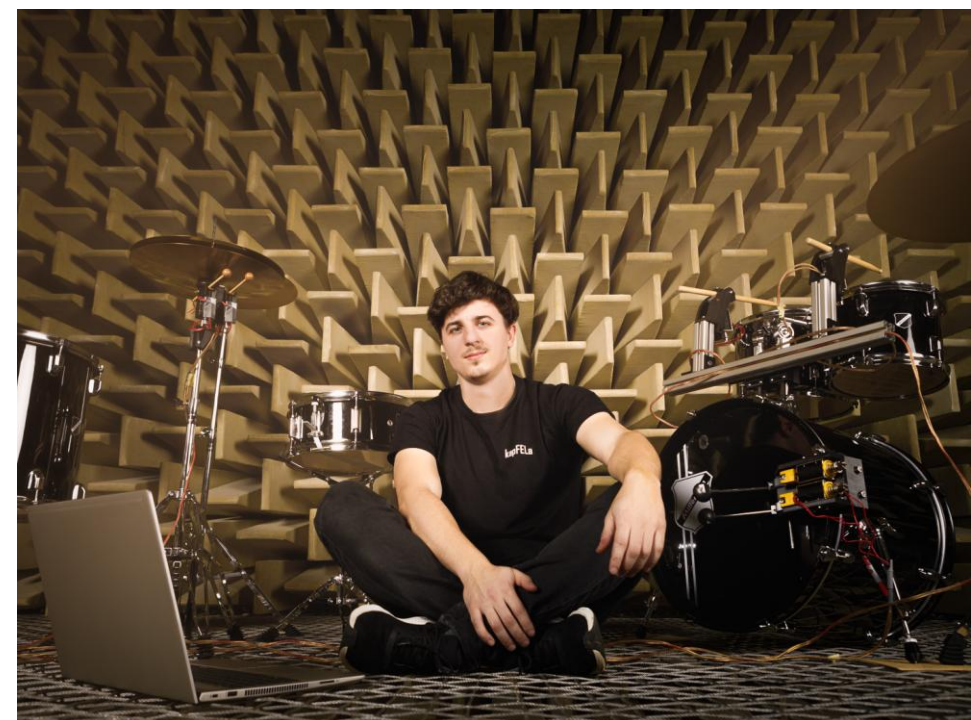
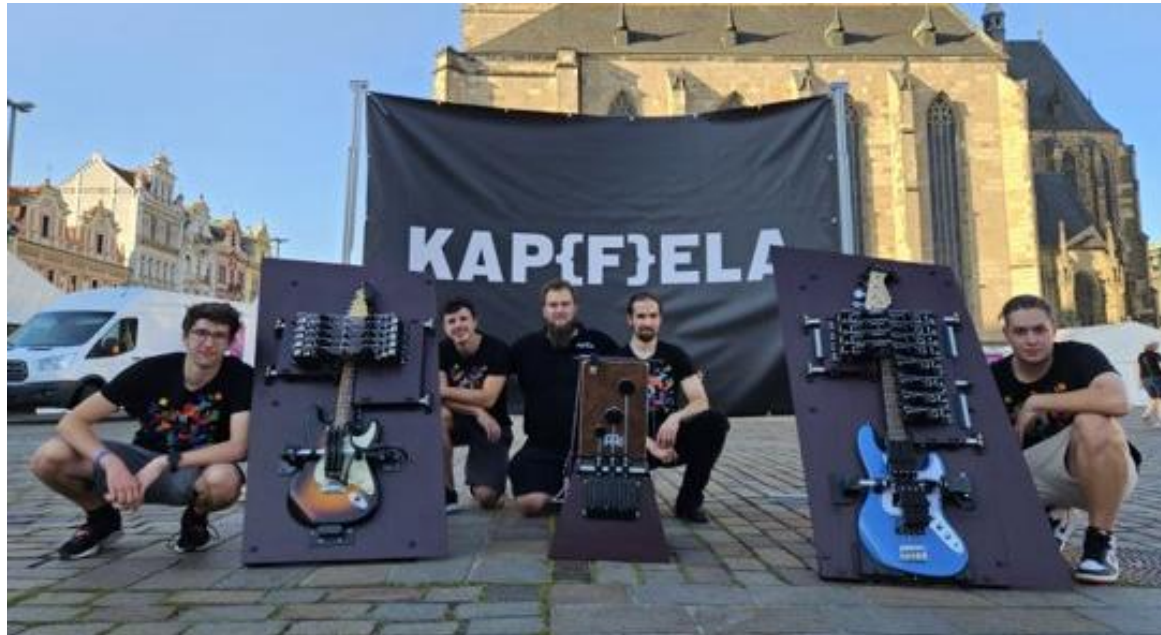
SOLENOID VALVES

- Control of the flow of liquids and gases
- Thanks to the control electronics, the valve can have its own intelligence and other advanced functions
- valves for high pressures, cryogenic temperatures, pressure control and smart homes



KapFELa

- A robotic band playing real instruments such as electric guitar, bass guitar, or drums
- Non-invasive solution for the construction of robot-controlled tools
- Student project

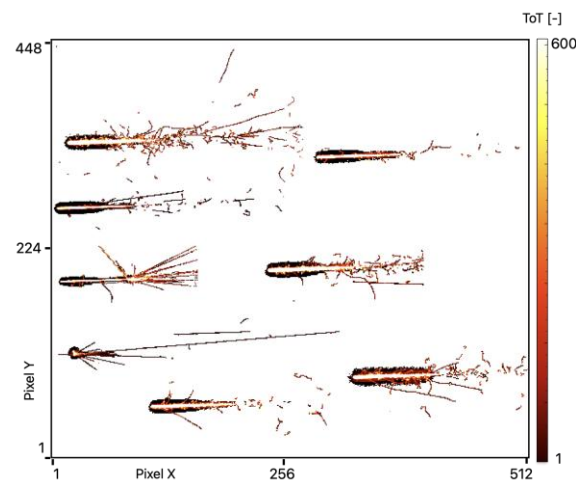
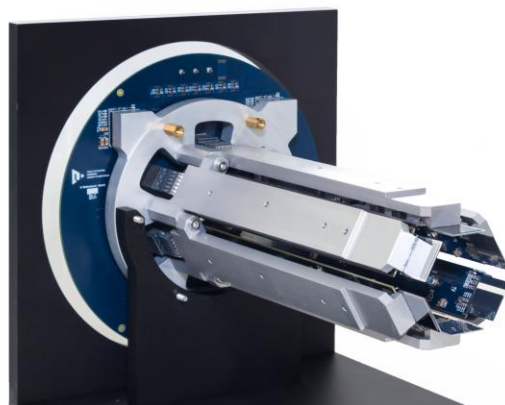
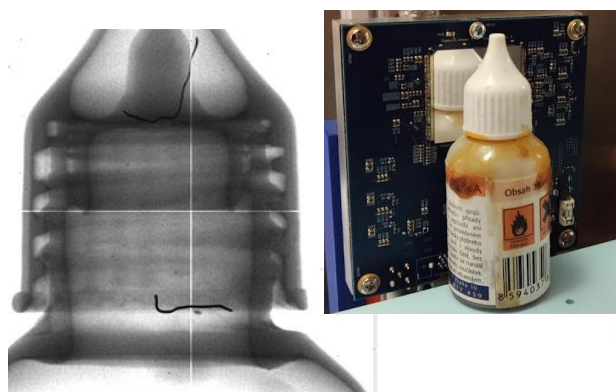


PHYSICS INSTRUMENTATION

DEVELOPMENT OF SPECIAL ELECTRONICS FOR PHYSICS EXPERIMENTS

Development of complete measurement chains for physics experiments, including sensor boards, readout electronics, and specialized control software

- Katherine devices: Readout systems (DAQs) for pixel particle detectors (Timepix family)
- Currently support of Timepix2, 3 and 4
- Complete acquisition chain from custom chipboard design to control software
- Design of chipboards: large area, radiation-hardened, specialized
- Interfaces: Gigabit Ethernet, USB 3.1, and PCIe Gen3
- Utilization: physics experiments, x-ray imaging, radiation monitoring, and material research
- Key partners: IEAP CTU in Prague, CERN



DEVELOPMENT OF SPECIAL ELECTRONICS FOR PHYSICS EXPERIMENTS

Precise time measurement

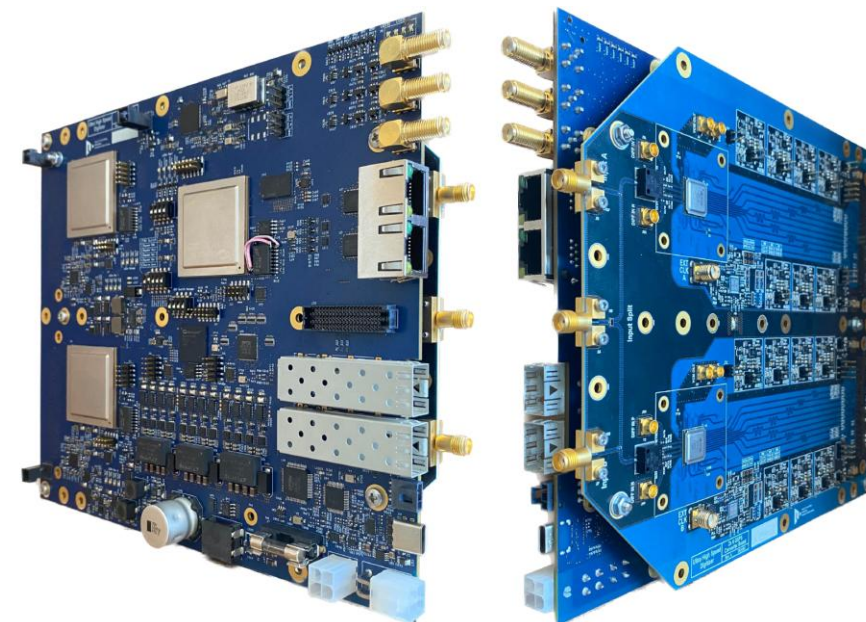
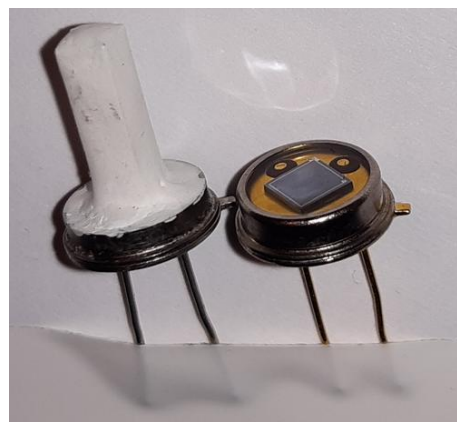
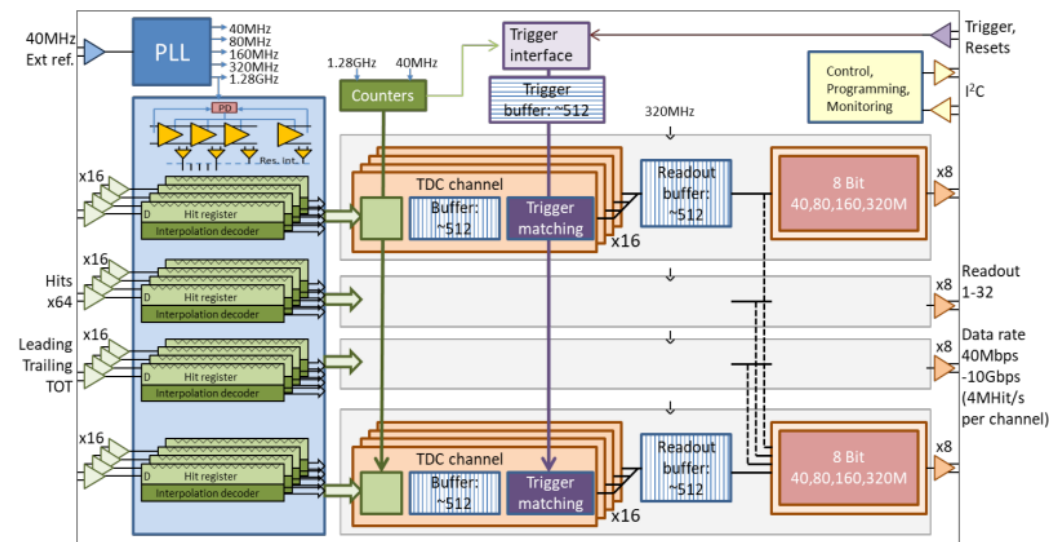
- Several types of TDC devices (based on commercial components)
- PicoTDC (designed by CERN, release for commercial purpose) – time binning 3.2 ps

Modular high-speed digitizer platform

- Up to 40 GS/s
- 9 GHz Bandwidth (-3dB)
- Optical Link (to PCIe) or USB 3.0 communication interfaces

SiPM for scintillators

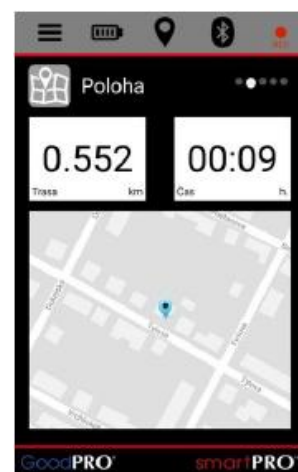
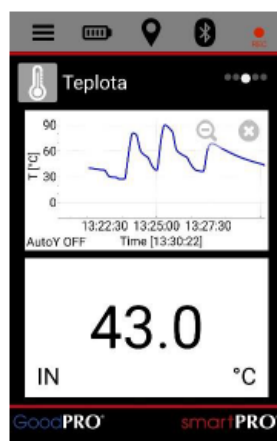
- Usage of Micropixel Avalanche Photodiode (MAPD)
- Spectroscopic chain with USB interface
- Close cooperation with Azerbaijan National Academy of Sciences
- Opportunity to influence of MAPD design process



ELECTRONICS AND TESTING

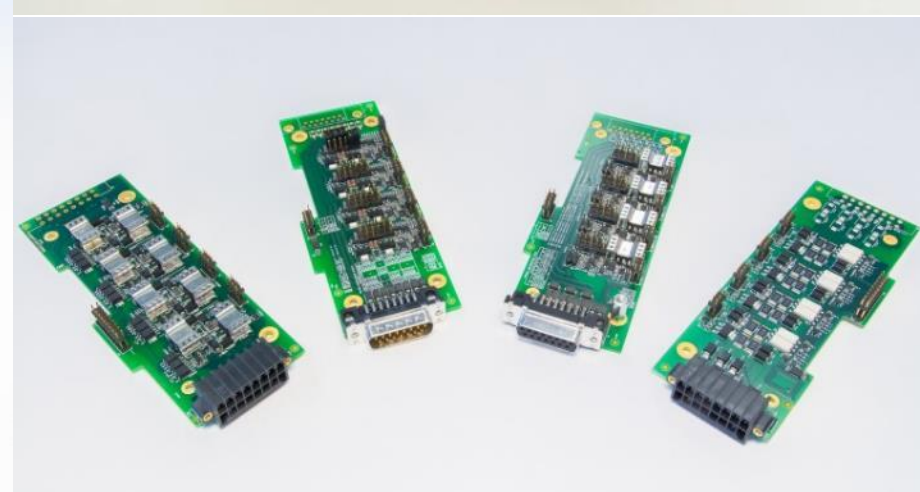
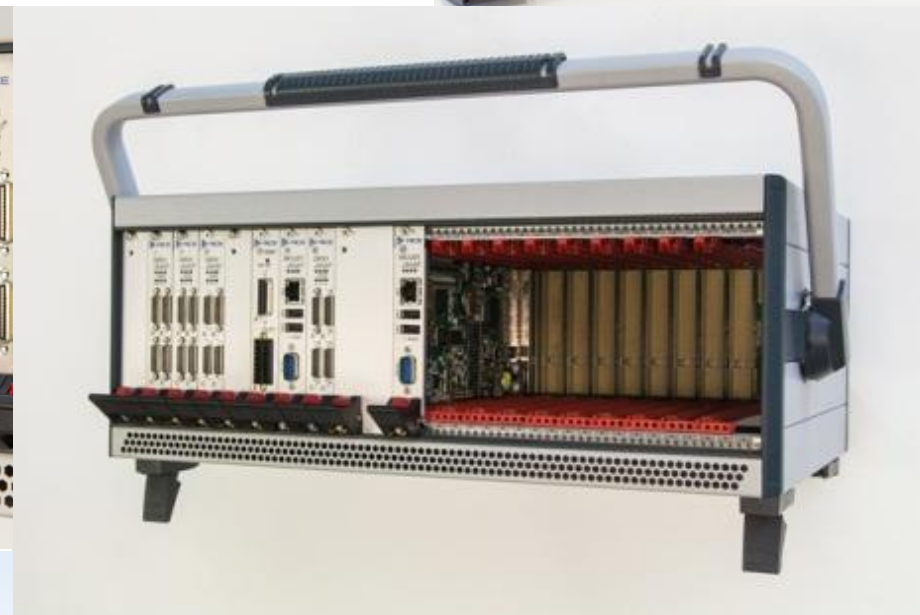
ELECTRONICS FOR SMART FIREFIGHTER SUITS

- IECEx II 2G Ex ib op is IIC T4 Gb certification (ATEX)
- Electronics fully integrated into suit
- Conductive ribbons used
- Machine washable (aggressive detergents)



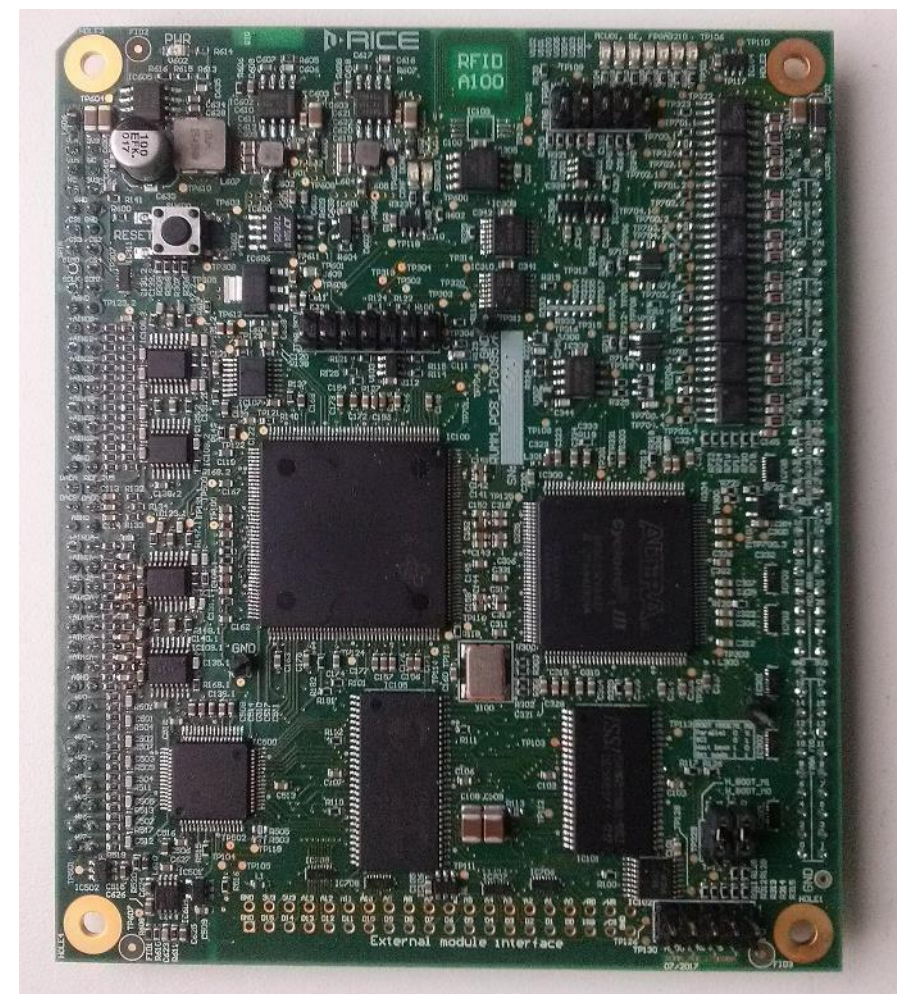
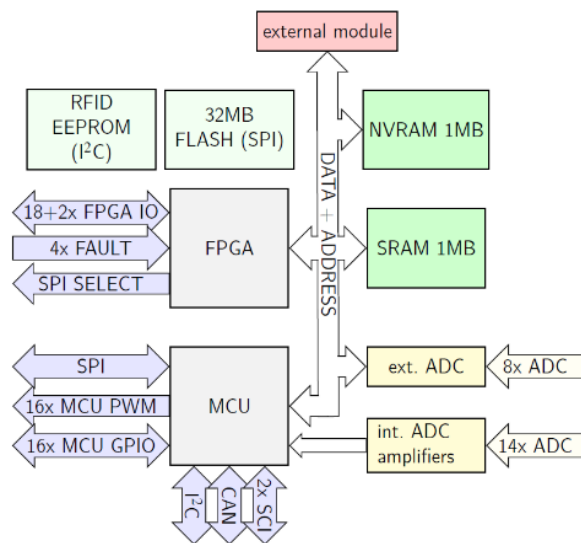
RICE EMBEDDED MODULAR CONTROL SYSTEM

- Modular control system
- Fully digital backplane
- High speed communication (2 x 2 Gbps LVDS)
- Cyclone V SoC (Cyclone III on simple boards)
- Extended safety features (SIL2)
- Variable input voltage levels (24V, 48V, 110V, 230VAC)
- Support of distributed control system architecture
- Single-board variants available



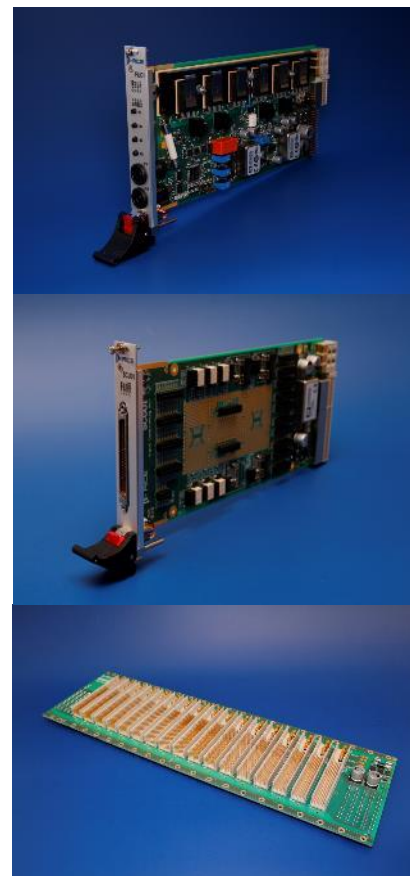
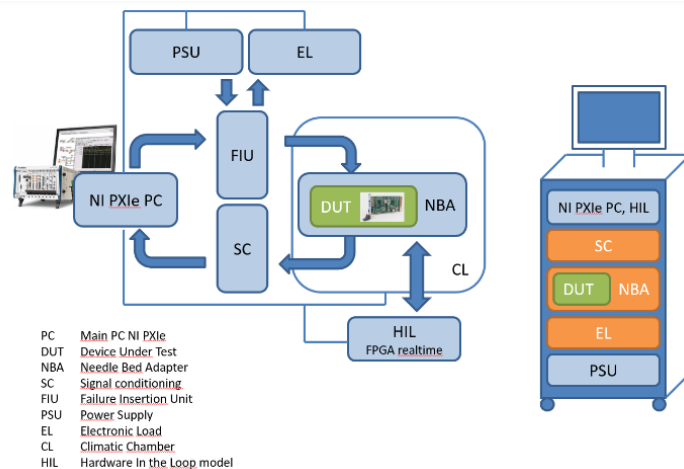
SMALL CONTROL BOARDS

- Single board control units for power converters
- DSP - TMS320F28377
- FPGA - Cyclone III
- NVRAM – 1M, data FLASH 32M
- 16x PWM,
- 8x ADC 14bit, 3x ADC
- CAN bus



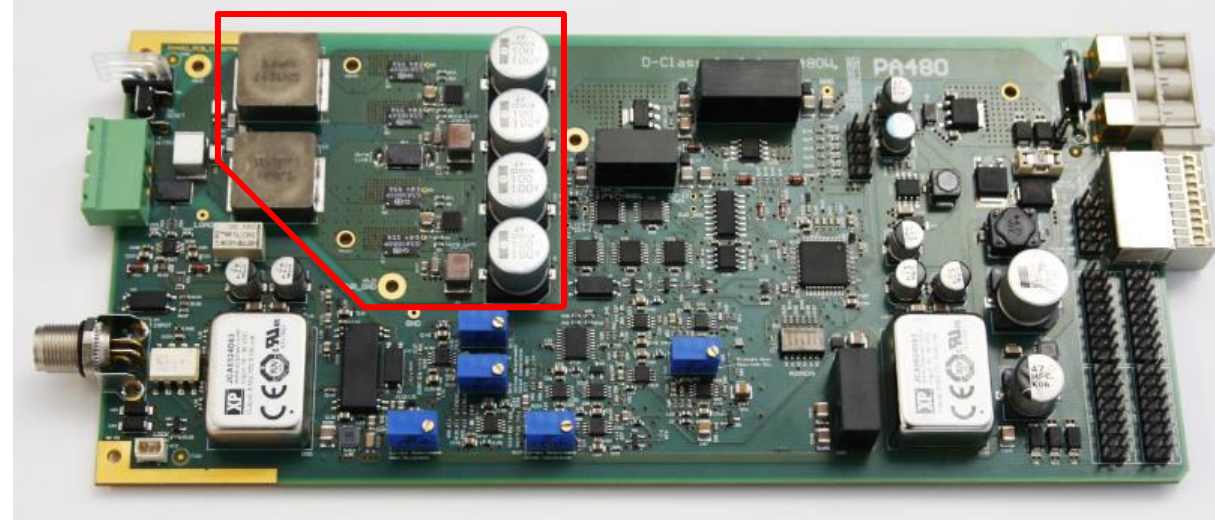
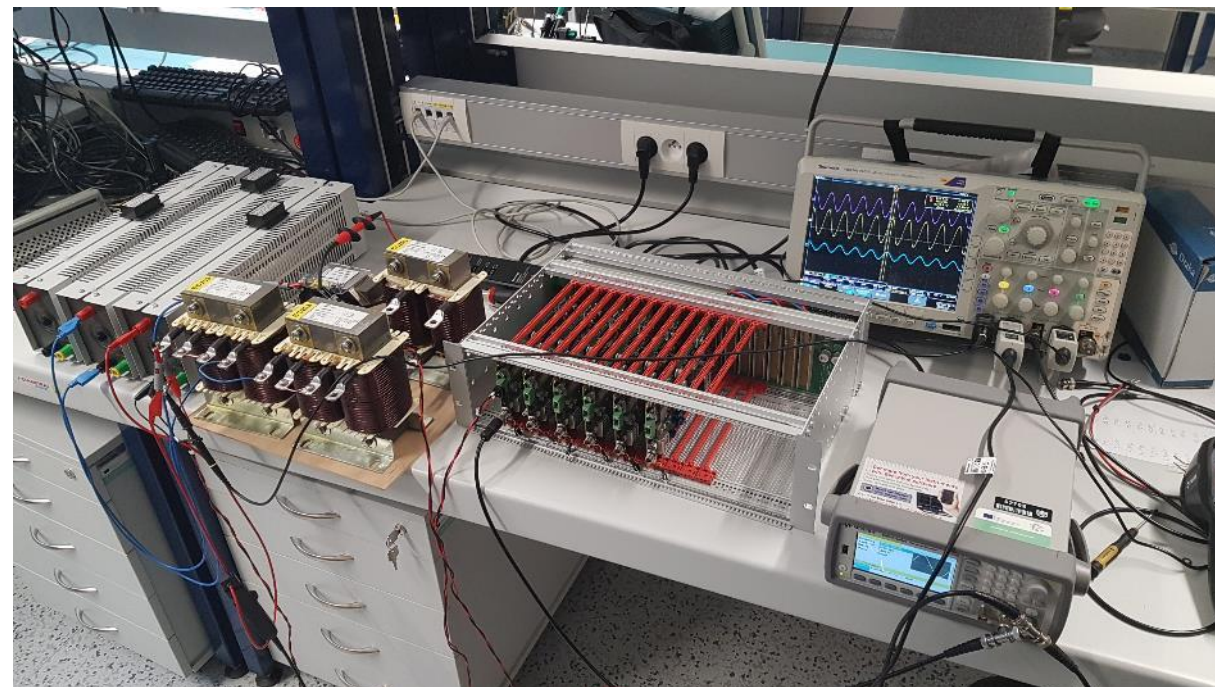
ELECTRONICS FOR AUTOMATED TEST SYSTEMS

- Test systems for nuclear power plant developers (testing of control system boards for uranium rods positioning)
- Modular structure - 3U cards + signal backplane
- Signal conditioning modules
- Failure insertion modules (40 A, 300 V, shortcuts, microcuts...)
- Signal switching modules (128 channels)
- Power switching modules...



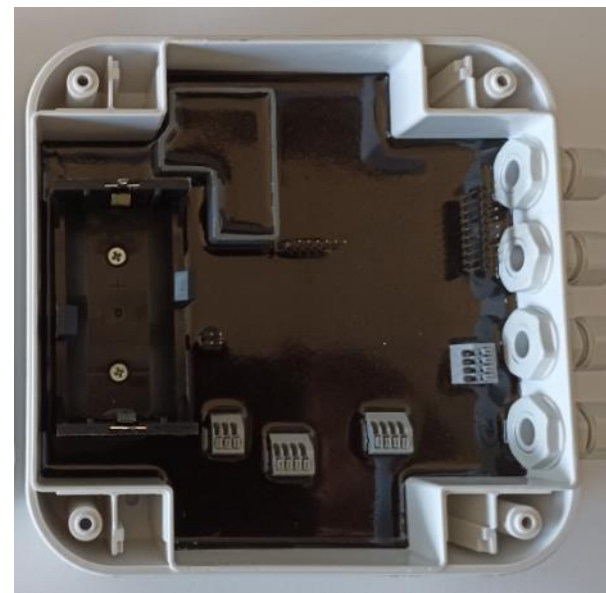
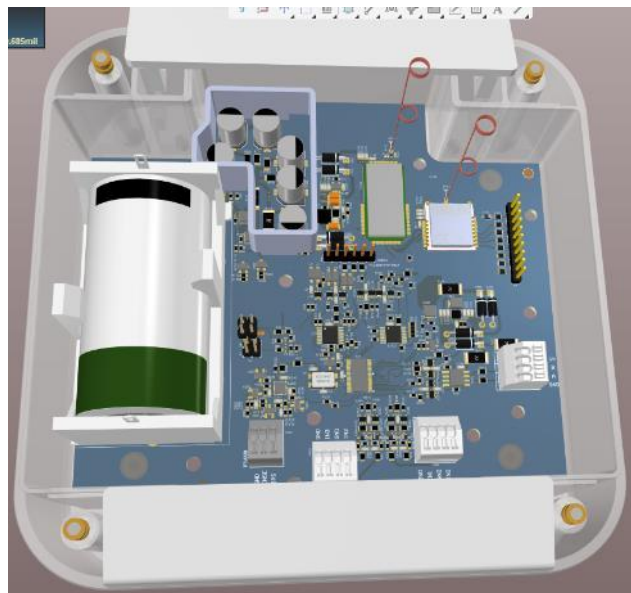
EMBEDDED POWER AMPLIFIER

- Integrated as part of an analog measurement module
- GaN technology
- 500W (max 60 V, 20 A) DC-60 kHz
- Switching frequency: 600 kHz
- Passive cooling



IoT MODULES FOR EXPLOSIVE ENVIRONMENT

- IECEx II 3G Ex ic IIA T3 Gc certification
- Target: Gas distribution infrastructures
- Low power applications (5-year battery life)
- Pressure, temperature, SO₂, M-bus sensors

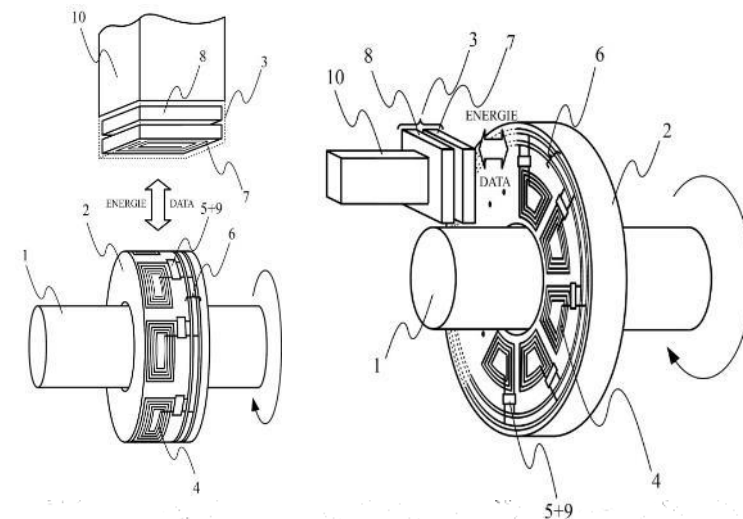
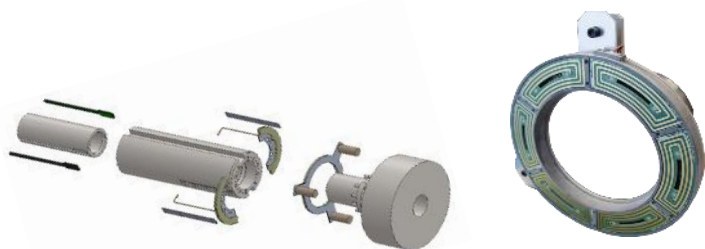


ELECTRONICS FOR WIRELESS POWER TRANSFER SYSTEMS

Patented solution for rotating machines (axial/radial variant)

Applications:

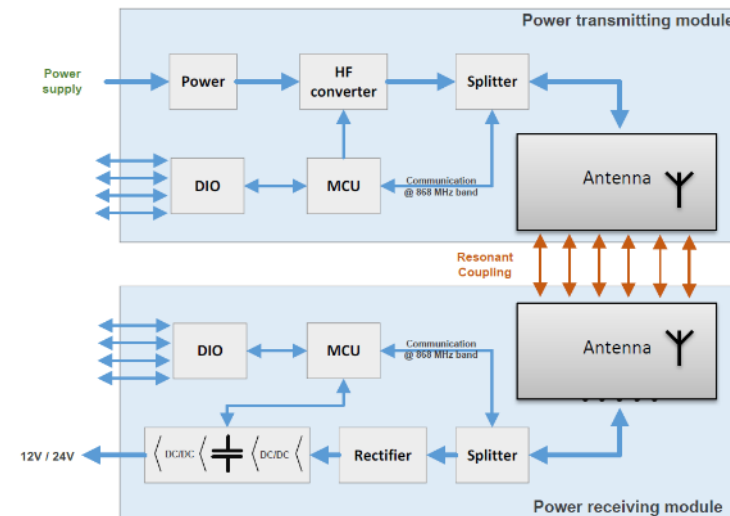
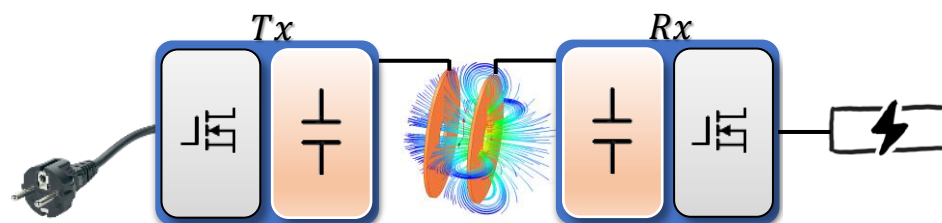
- Compensation of temperature dilatation (machining spindle)
- Rotor diagnostics for 2MW generator (48ch)
- CNC machine accessory



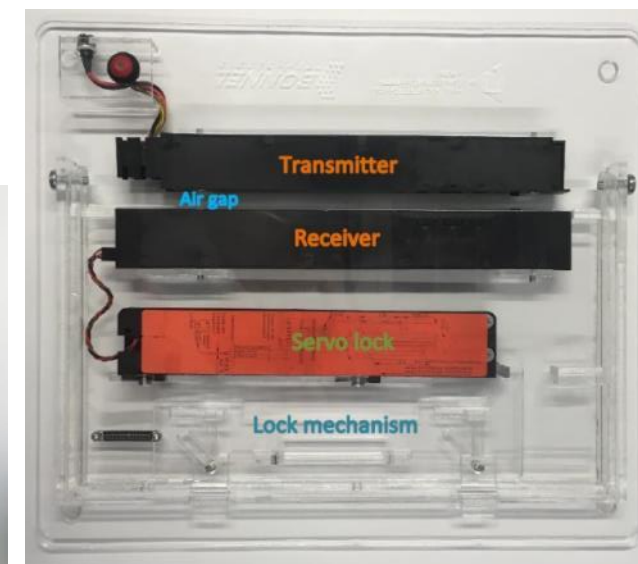
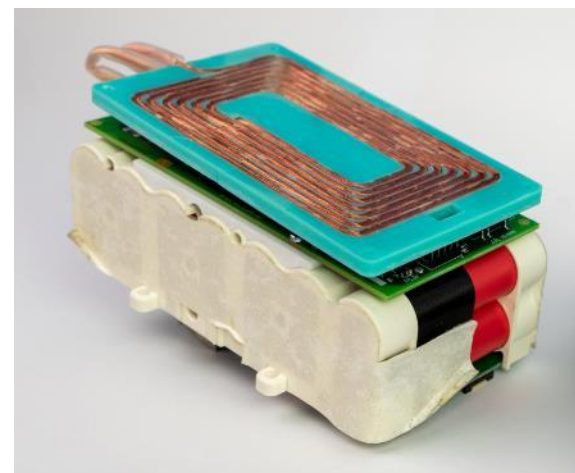
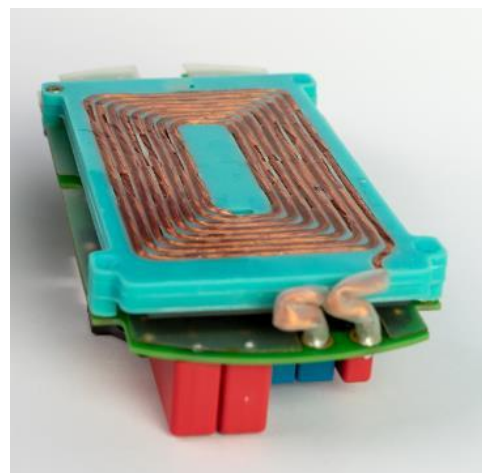
ELECTRONICS FOR WIRELESS POWER TRANSFER SYSTEMS

Applications

- Handtools for firefighters - battery charging (ATEX)
- Power supply for door&window locks (built in the door frame) - patent pending
- Communication modulated on power supply signal

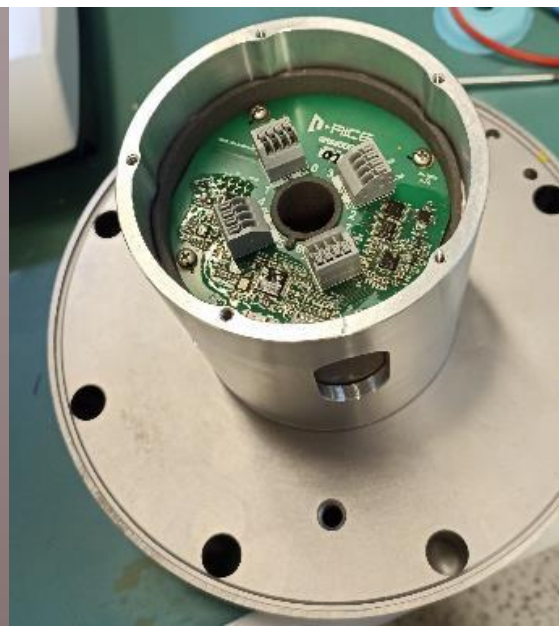
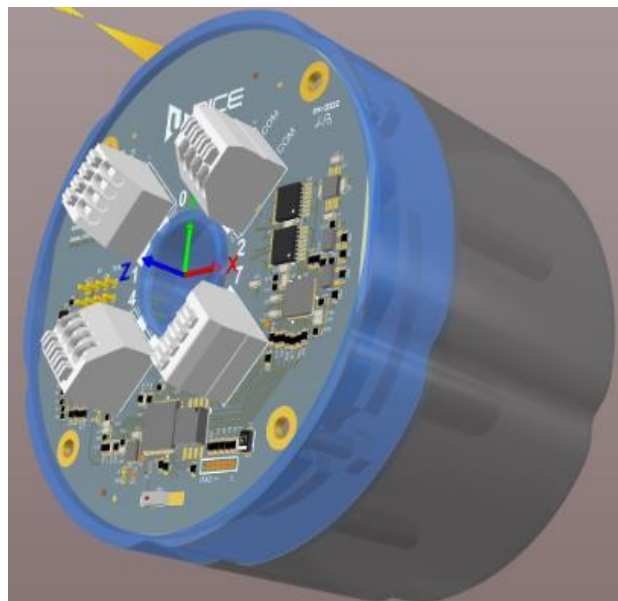
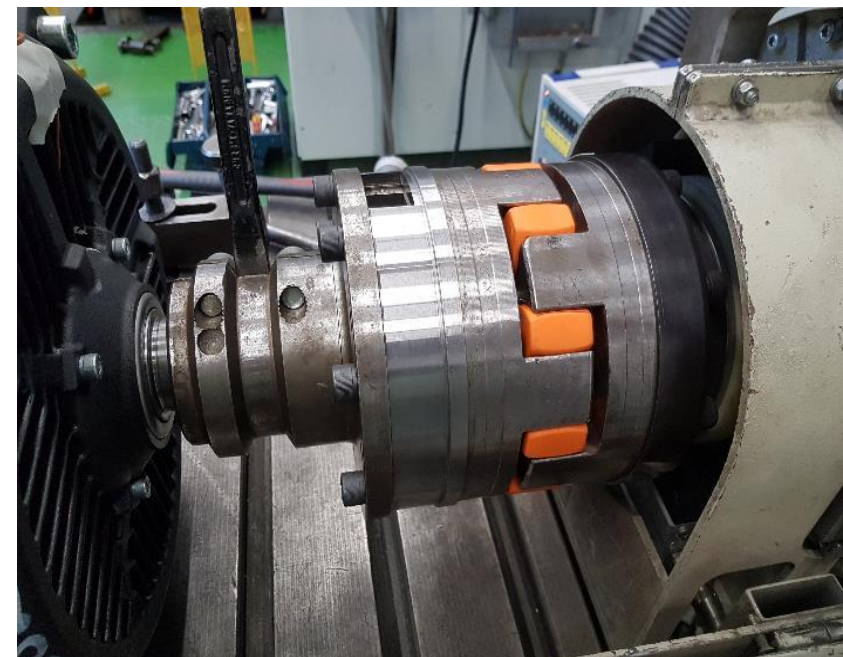


FEL UWB | RICE fel.zcu.cz



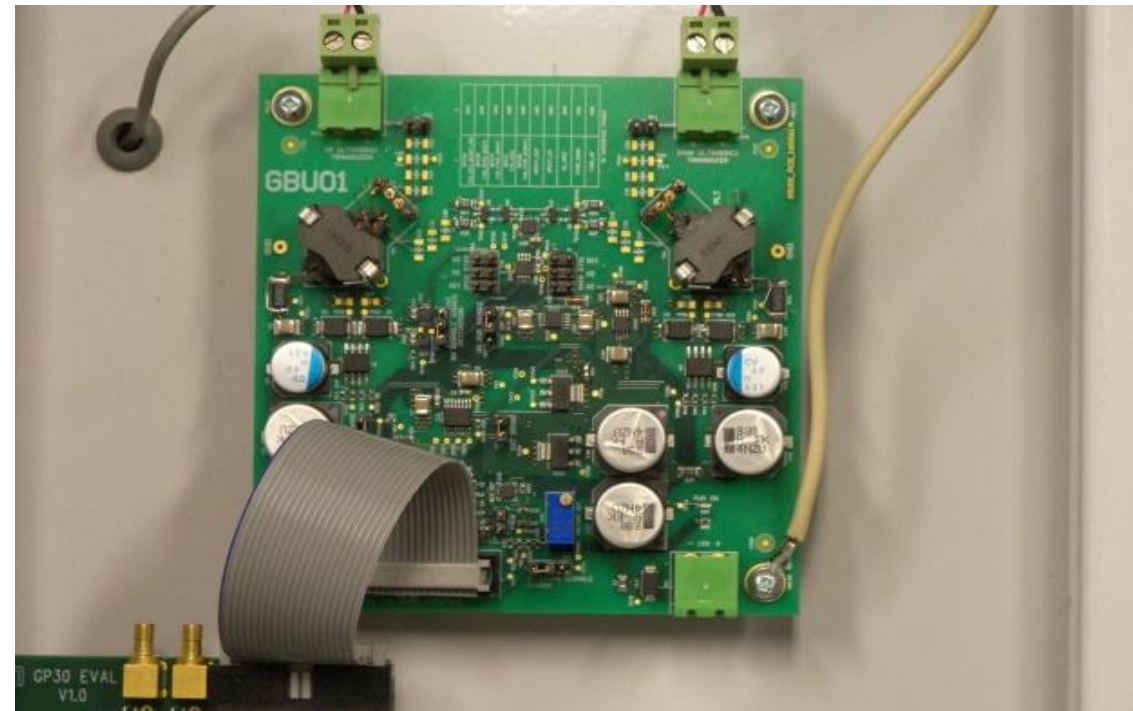
DIAGNOSTICS – HIGH SPEED ROTATING SYSTEMS

- DAQ for rotor diagnostics (test facility)
- Built in clutch
- 6000 rpm (10000 rpm version under development)
- 8ch 16bit
- Low power Bluetooth communication



ELECTRONICS FOR ULTRASONIC FLOWMETERS

- Water and gas ultrasonic flowmeters
- High precision time measurement
- Single or dual beam variants
- Ratio 1:500
- 100...1000 mm diameter



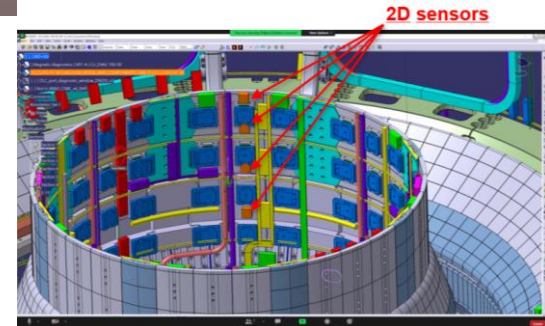
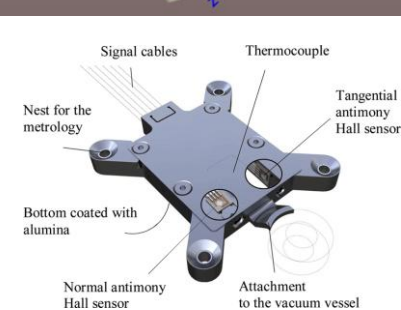
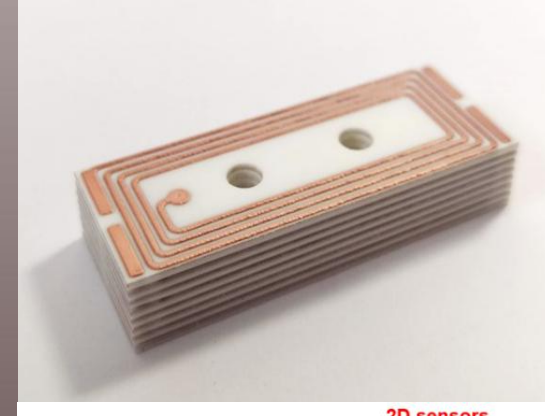
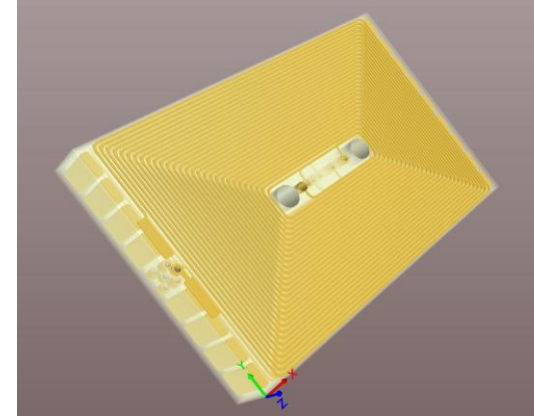
COMPETENCE: SENSORS AND DETECTORS (SELECTED REFERENCES)

Hybrid pixel radiation detectors

- Developed within Medipix3 Collaboration, CERN
- Readout chip & sensor – Si, CdTe, GaAs etc.
- References: CERN

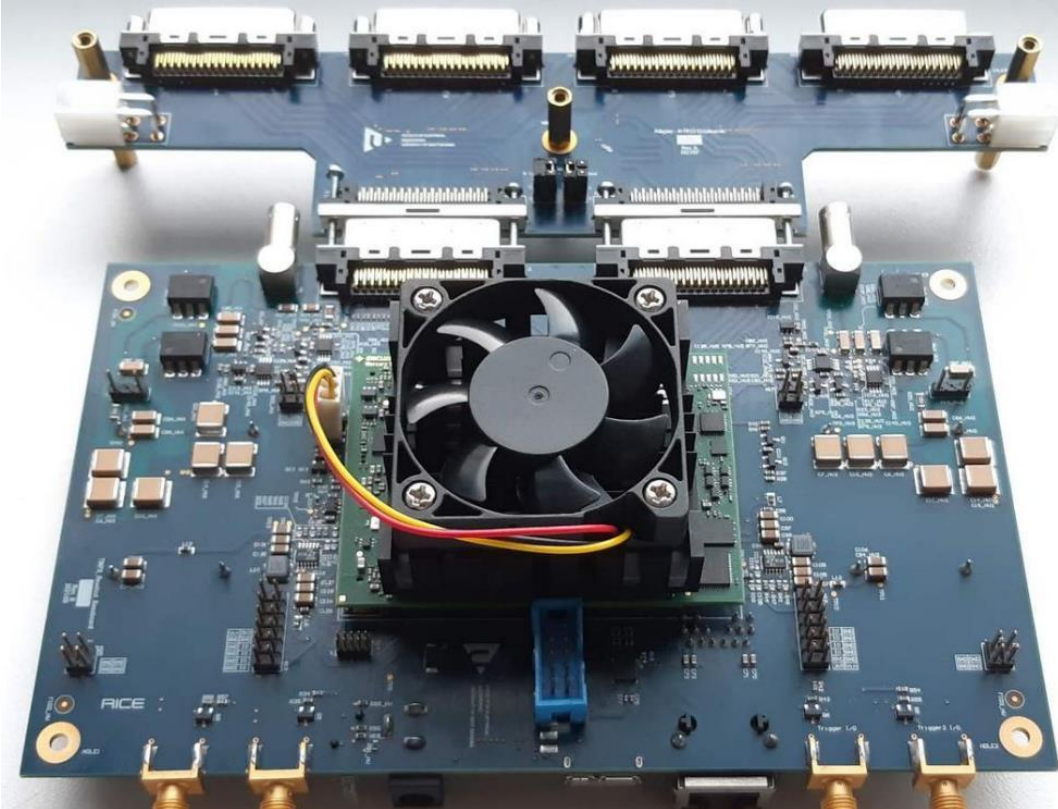
Plasma position sensors for fusion reactors (TOKAMAK)

- Competences: Spinel (Al_2MgO_4) substrate; low % of glass in substrate
- High dielectric strength
- New manufacturing technology
- High temperatures ($\sim 500^\circ\text{C}$)
- High neutron flow resistance, combined sensors
- Reference: ITER/DEMO



READ-OUT BOARDS FOR PIXELATED DETECTORS

- FPGA Intel SOC (5CSTFD6)
- 2GB DDR
- ARM® dual-core Cortex™-A9
- 294 users I/O
- 1Gb Ethernet, USB3.0 (up to 3.2Gb)
- SERDES 640Mbps per lane with 10b/8b
- High voltage source (500V or up to 1kV with current measurement) – positive and negative
- SFP modules for optical communication



PRECISE EVENT DETECTORS

- Precise time synchronization for CERN experiments
- Time measurement with 13ps resolution
- FPGA Cyclone IV (22k LE; 153 users I/O)
- USB3.0 (1.6Gbps)
- Range up to 7s (40b data word)
- 4 measurement channels + 1 return channel useful for synchronization

