CXI TUL

Structure of research at CXI

- three progressive research directions

- differences in scientific focus and expertise; however, mutual cooperation

- each research direction lead by guarantor

Structure of research at CXI

- NANOMATERIALS IN NATURAL SCIENCES
- COMPETITIVE ENGINEERING
- SYSTEM INTEGRATION

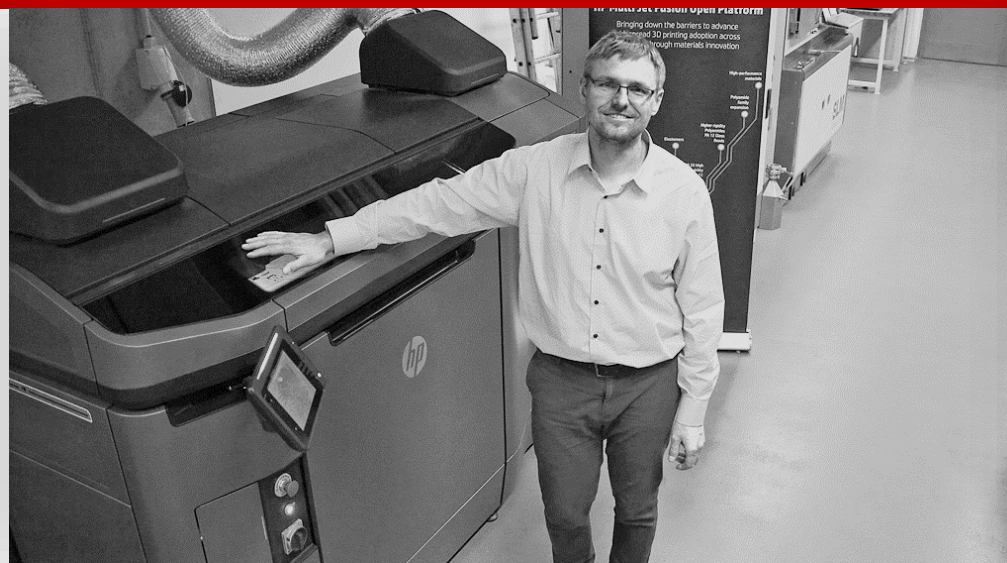# RESEARCH DIRECTIONS

CXI DIRECTOR
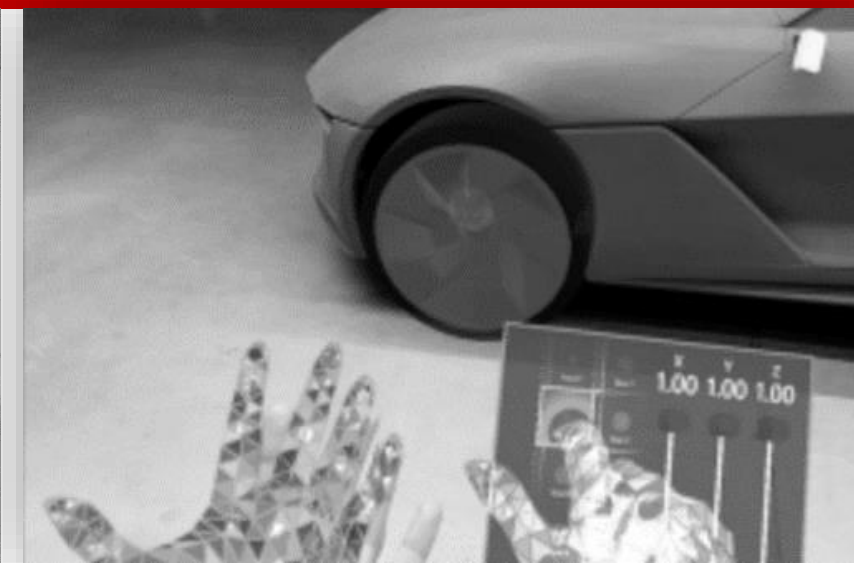Miroslav Cernik

RESEARCH DIRECTOR
Michal Petru

NANOMATERIALS IN NATURAL SCIENCES (RD1)

Lukas Dvorak

COMPETITIVE ENGINEERING (RD2)

Jiri Safka

SYSTEM INTEGRATION (RD3)

Jan Koci

NANOMATERIALS IN NATURAL SCIENCES

DEPARTMENT OF NANOCHEMISTRY

DEPARTMENT OF ENVIRONMENTAL TECHNOLOGY

DEPARTMENT OF APPLIED BIOLOGY

DEPARTMENT OF ENVIRONMENTAL CHEMISTRY

The research direction of nanomaterials in natural sciences combines basic research, technology and construction of pilot and professional biomass carriers, purification and analysis of environmental contaminants and testing of nanomaterials.

COMPETITIVE ENGINEERING

DEPARTMENT OF
3D TECHNOLOGIES

DEPARTMENT OF
VEHICLES

DEPARTMENT OF
MACHINES DESIGN
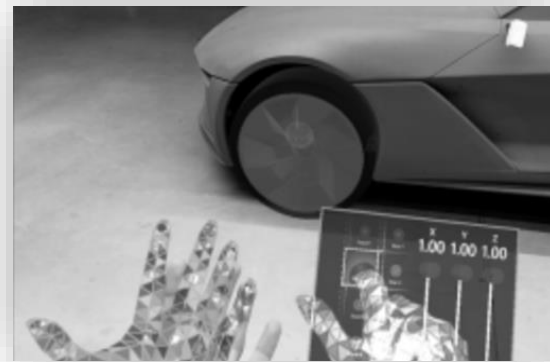
DEPARTMENT OF
ADVANCED
TECHNOLOGIES

DEPARTMENT OF
ADVANCED
MATERIALS

The research direction of competitive engineering combines research and development in the areas of manufacturing and the automotive industry with great application potential. The workplaces support the industrial activities of companies not just in the close-by regions and focus on the application of new technologies and technological procedures to ensure a higher degree of innovation in industrial production.
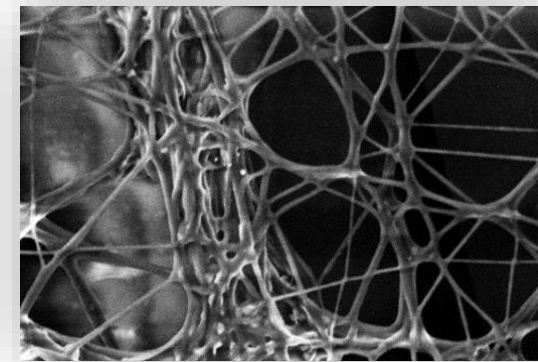
SYSTEM INTEGRATION

DEPARTMENT OF

SW ARCHITECTURE AND DEVELOPMENT
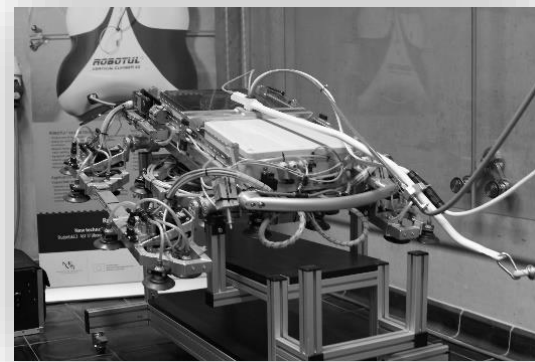
DEPARTMENT OF

MECHATRONIC SYSTEMS AND ROBOTICS

DEPARTMENT OF

PROCESS MODELING & AI

DEPARTMENT OF

PHYSICAL MEASUREMENTS

Focus on research and development of modern software solutions, system solutions for data processing and integration between systems, and the provision of communication interfaces. An integral part is the field of robotics, including the use of collaborative or sensitive robots. The emphasis is being put on the introduction of state-of-the-art elements of visualization and projection of measured data, including the use of MR/AR.

CXI competence fields

Autonomous systems
autonomous and cooperative systems
autonomous utility electrovehicle

Additive manufacturing
3D printing including metallic prints and
reinforcing by advanced materials

Advanced materials and machines design
the new light-weight and sustainable components,
innovative design and systematic planning of technical
systems innovations

Green technologies, up-scaling
environmental friendly products, piloting
of technologies

Augmented reality
collaboration & remote assistance, mixed reality
wearables

Environmental protection
(waste) water and groundwater treatment,
waste disposal, air filtration

BIG DATA, artificial intelligence
big data storage and analysis, machine learning & AI,
image and pattern recognition

Risk of nanomaterials, high-tech analysis
environmental risk of nanomaterials, advanced
analytical techniques

Industrial IoT
advanced sensors, displays, edge and cloud computing,
5G and SigFox networks

CXI
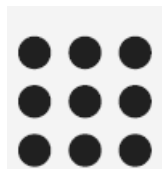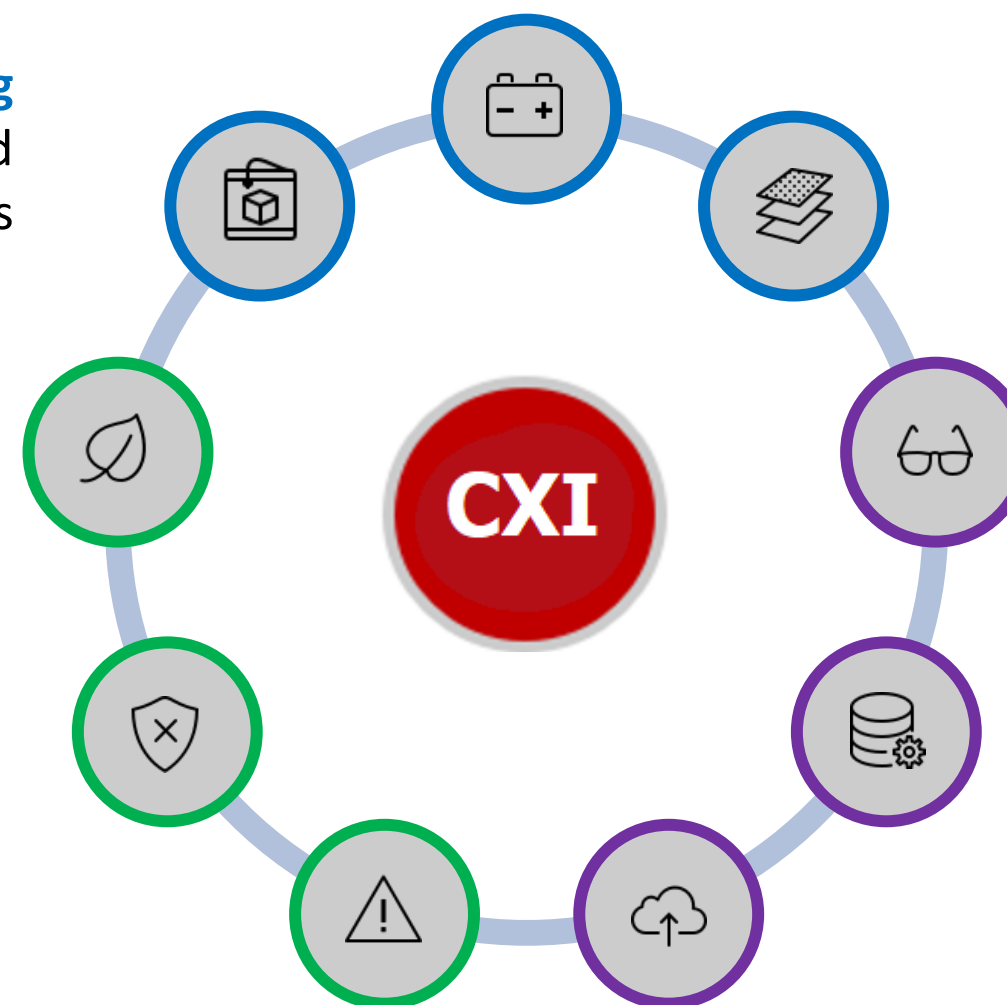
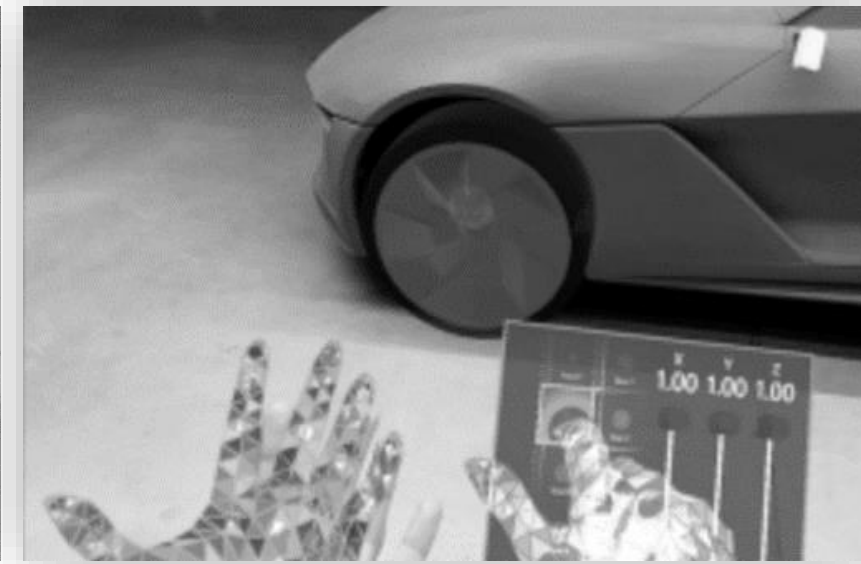# RESEARCH DIRECTIONS

NANOMATERIALS IN NATURAL SCIENCES (RD1)

Lukas Dvorak

COMPETITIVE ENGINEERING (RD2)

Jiri Safka

SYSTEM INTEGRATION (RD3)

Jan Koci

FOCUS OF RD3

modern cloud ready SW solutions, system solutions for data storage, analysis and processing, process modelling and digital twins, integration architecture of systems or devices, communication interfaces, design and development control software or mechatronic systems, robotics including collaborative robots, physical measurements, visualisation and projection of measured data, including the use of augmented reality …

Departments of RD3

PROCESS MODELLING AND ARTIFICIAL INTELLIGENCE
lead by Ing. Jan Koci

SOFTWARE ARCHITECTURE AND DEVELOPMENT
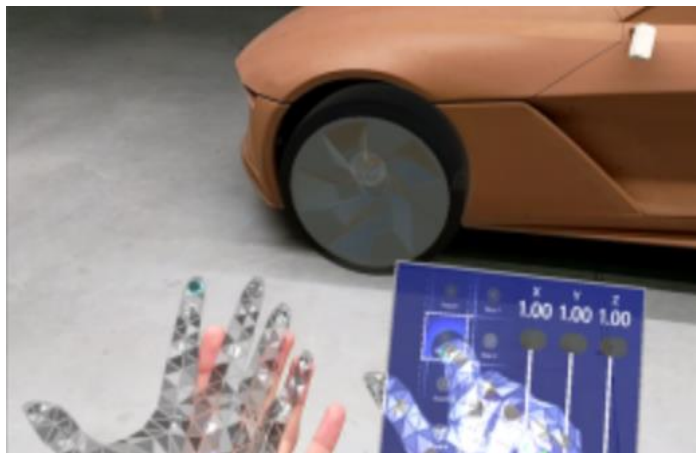lead by Ing. Jindrich Cyrus, Ph.D.

PHYSICAL MEASUREMENTS
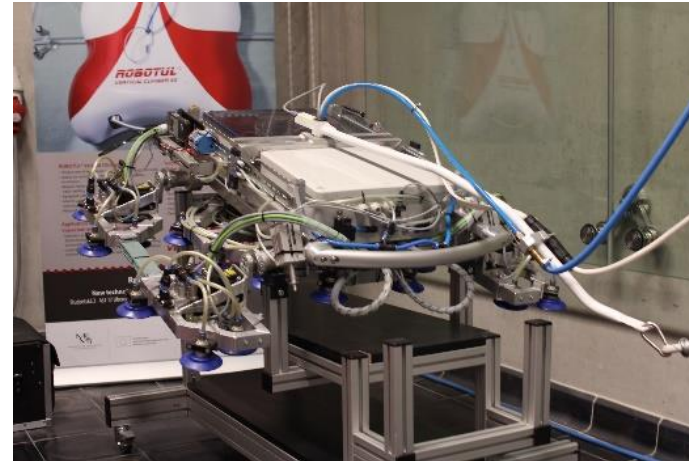lead by Ing. Michal Kotek, Ph.D.

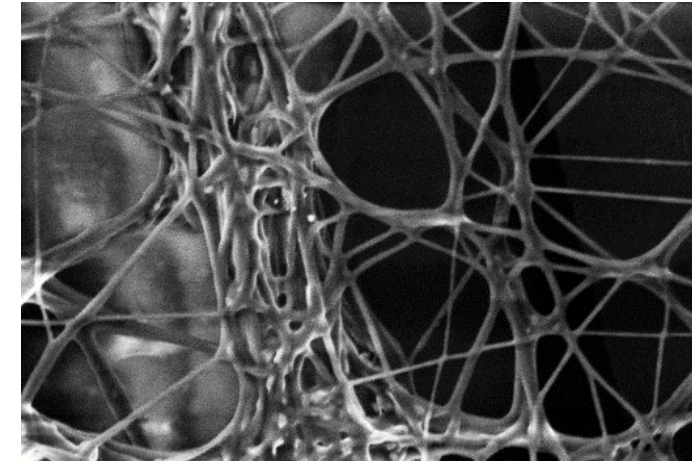**MECHATRONIC SYSTEMS AND ROBOTICS**
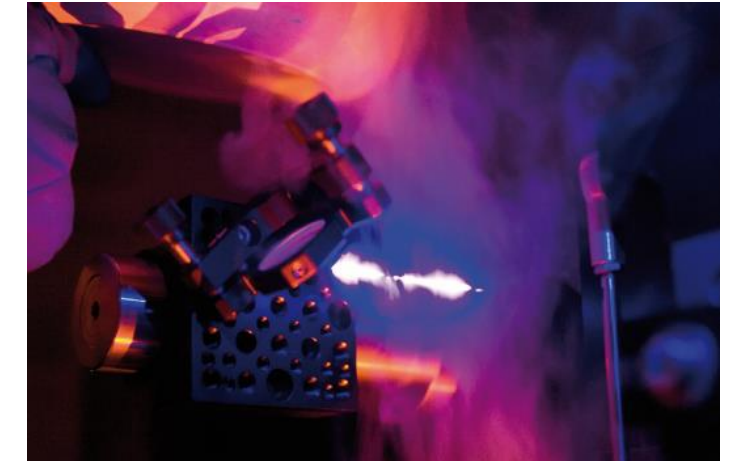lead by doc. Ing. Petr Tůma, CSc.

DEPARTMENT OF SW ARCHITECTURE AND DEVELOPMENT

DEPARTMENT OF MECHATRONIC SYSTEMS AND ROBOTICS

DEPARTMENT OF PROCESS MODELLING & AI

DEPARTMENT OF PHYSICAL MEASUREMENTS

The research direction **system integration** focuses on research and development of modern software solutions, system solutions for data processing and integration between systems, and the provision of communication interfaces. An integral part of the direction is the field of robotics, including the use of collaborative or sensitive robots. The emphasis is being put on the introduction of state-of-the-art elements of visualization and projection of measured data, including the use of mixed / augmented reality.

Ing. Jan Kočí

Guarantor of research direction System Integration and Department of Process Modelling and AI

PROCESS MODELLING AND ARTIFICIAL INTELLIGENCE

The department focuses on process modelling using mathematical, physical and numerical methods or principles of machine learning and artificial intelligence, robot process automation, big data storage, processing and analysis and overall application of data-driven approach to business or manufacturing processes. All these principles are then used in the design and solution of digital twin tasks, industrial vision, image or sound recognition and advanced data-driven predictive systems
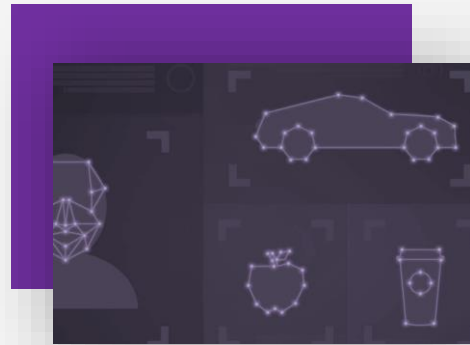
Image & pattern recognition

Tools for real-time or offline data analysis in order to recognize objects, patterns in streamlined data, tools for industrial computer vision implementation

Machine learning & prediction models

Modelling of processes using mathematical/statistical models, ML and AI principles towards predictions in various areas or advanced control systems.
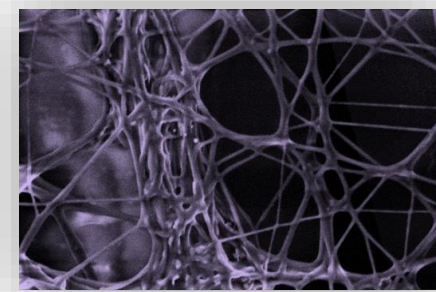
Data storage, analysis, reporting

Solutions for structured/unstructured (hadoop) data storage, cloud storages, various analytic tools and reporting platforms to manipulate/visualize data.
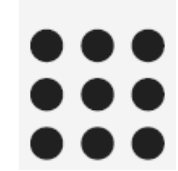
Robotic process automation

Software robot operates applications in the same way as a human. It uses a user interface, so there is no need to modify existing systems to automate processes.

Ing.
Jindřich Cýrus, Ph.D.

Department of
SW Architecture
and Development

DEPARTMENT OF SW ARCHITECTURE AND DEVELOPMENT

MAIN RESEARCH ACTIVITIES

- Research and development of modern software solutions, system solutions for data processing, integration between systems and communication interfaces
- Design of sw and hw solution architecture, which is implemented in target processes, using IoT devices, Cloud services and augmented reality
- Pillars of Industry 4.0 in product design and development

COOPERATION

- Design and application of IoT Technologies
- Use of augmented and mixed reality
- Design and implementation of artificial intelligence algorithms into processes
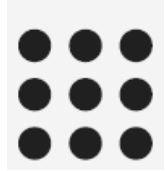- Cloud solutions architecture
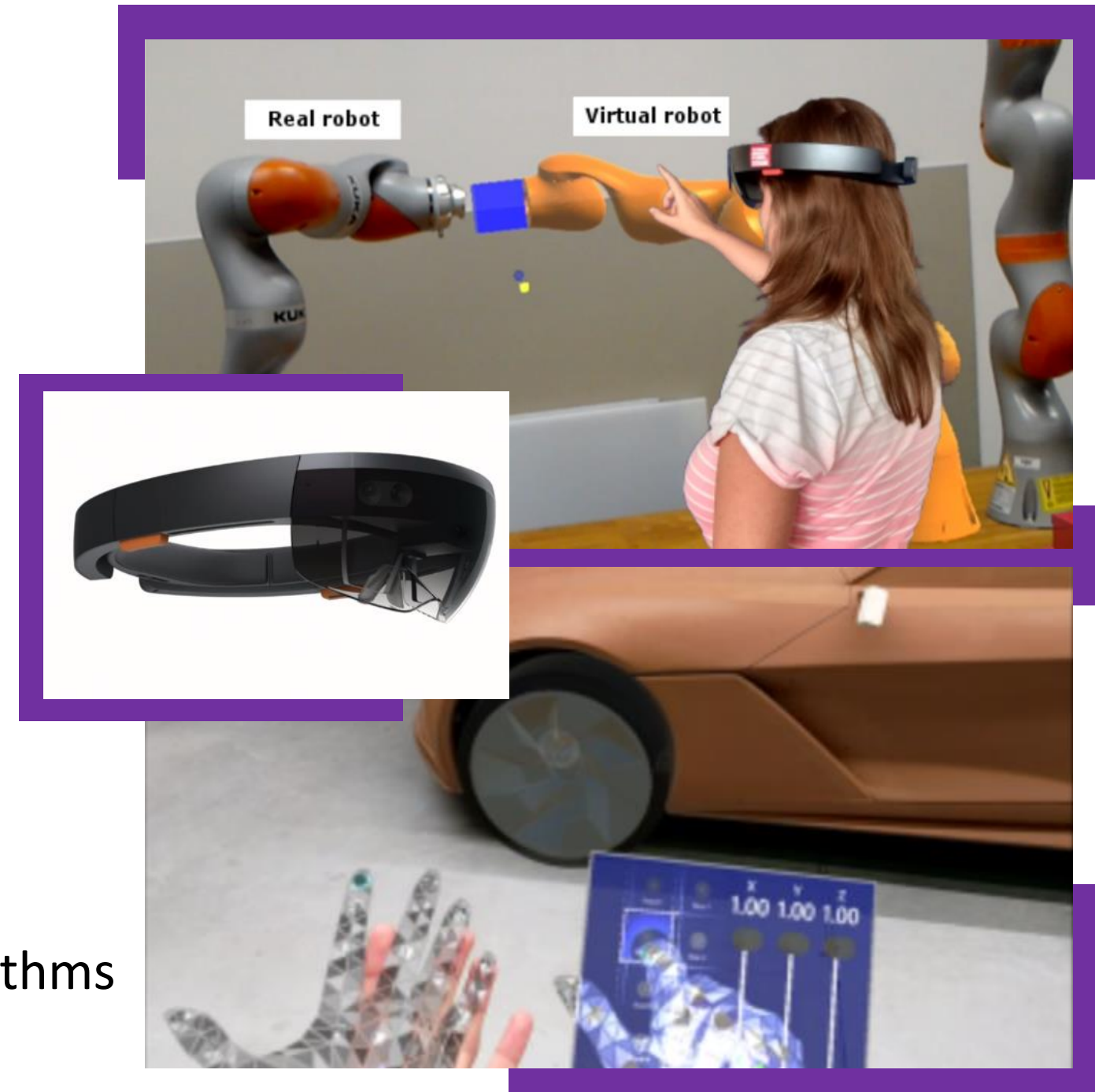
Ing.
Michal Kotek, Ph.D.

Department of
Physical Measurement

DEPARTMENT OF PHYSICAL MEASUREMENTS

MAIN RESEARCH ACTIVITIES

- Research, development and use of tools and methods for contactless detection and measurement
- Measurement of physical quantities in industrial technological processes
- Experimental research in fluid mechanics with emphasis on non-stationary and multiphase flow
- Image information processing in industry

COOPERATION

- Application of "Global Imaging Methods" (LDA, PIV, microPIV, PLIF, IPI) in experimental fluid mechanics
- Advanced forms of industrial automation
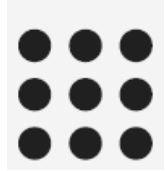- Monitoring and quality control of industrial products
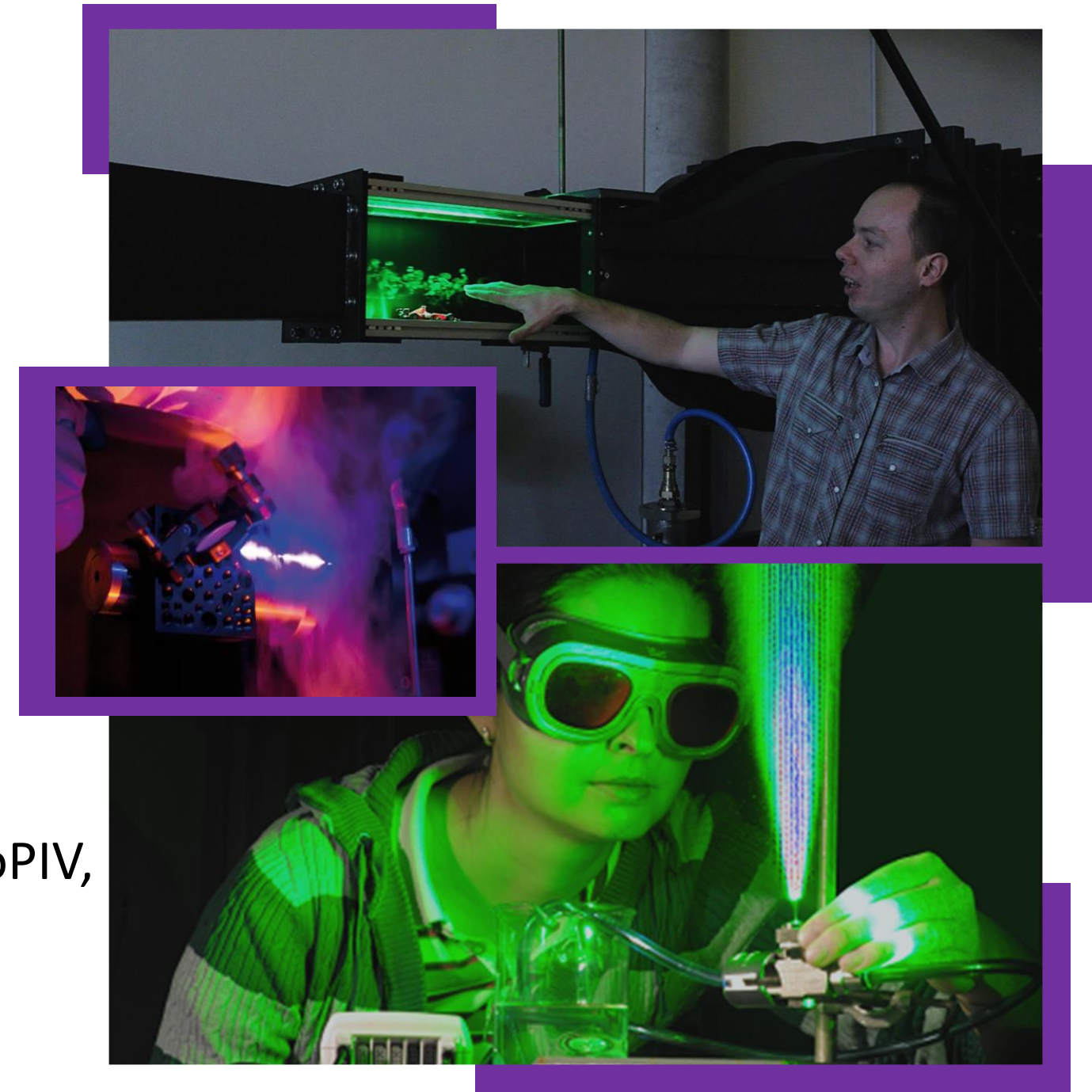
**Ing.
Tomáš Martinec, Ph.D.**

Department of
Mechatronic Systems
and Robotics

DEPARTMENT OF MECHATRONIC SYSTEMS AND ROBOTICS

MAIN RESEARCH ACTIVITIES

- Innovative research of autonomous service robots
- Development of partial equipment of robotic technological workplaces and integration into production lines
- Solution of specific structural nodes of industrial robots and their effectors, mechatronic elements of automation technology and peripherals of robotic workplaces

COOPERATION

- Implementation of elements with a high degree of intelligence and new materials in robotic and mechatronic systems with more degrees of freedom and in standard drive topologies
- Rehabilitation robotics (exercise bikes, medical beds, ..)

INSTITUTE FOR NANOMATERIALS,
ADVANCED TECHNOLOGIES
AND INNOVATION TUL

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cxi.tul.cz

Research on the Top