



# CEITEC

Central European Institute of Technology  
BRNO | CZECH REPUBLIC

annual report **2012**



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We have undergone our first full year of operations since CEITEC was established by the European Commission on 6<sup>th</sup> June 2011. CEITEC is a consortium whose partners include the most prominent universities and research institutes in Brno, Czech Republic. Although we are a new organization, our scientific activities are well underway. We currently have over 50 Research Group Leaders, with greater than 250 researchers working at CEITEC, and we have published more than 200 papers to date.

In September of 2012, the foundation stones of our two new campus complexes were put in place. This officially started the construction of our new buildings which will house the majority of our research activity and will include 25.000 m<sup>2</sup> of new work space. The buildings are scheduled to be opened in 2014, for researchers in both the life science and material science fields to start using the new facilities.

As with any new enterprise, our research organization is undergoing a great deal of changes. We have the advantage of having many of the very best researchers from the Brno area incorporated within our institute. Part of a new beginning for CEITEC is to include new research directions in order to stay current as new scientific developments evolve. CEITEC has undergone a great deal of expansion in its international personnel, and to this effect, we are happy to welcome our new Group Leaders, Hedi Hegyi, Peter Lukavsky, and Vanessa Tognetti.

Thanks go to the members of our Coordination Board for all of their hard work and dedication in steering the project in the right direction: PhD. Mikuláš Bek, Rector, Masaryk University; Prof. Karel Rais, Rector, Brno University of Technology; Prof. Jaroslav Hlušek, Rector, Mendel University in Brno; Prof. Vladimír Večerek, Rector, University of Veterinary and Pharmaceutical Sciences Brno; Prof. Ludvík Kunz, Director, Institute of Physics of Materials; and Prof. Břetislav Koudela, director, Veterinary Research Institute; and our external members Gustaaf Borghs, Jaroslav Doležal, Jiří Hudeček, Vladimír Král, and Stefan Maier.

I would also like to thank all of the members of our International Scientific Advisory Board, Professors Andrés Aguilera, Dirk Inzé, Christoph Michel, Yoshio Nishi, Hartmut Oschkinat, with special thanks to our Chairman, Wolfgang Knoll.

Lastly, I would like to thank all of the faculty, post-doctoral fellows, students, and staff of CEITEC, both within the Central Management Structure and our six partners, for striving to make CEITEC a great place for scientific discovery. It is a great pleasure to work with an organization that can generate compelling ideas and has the energy to push the boundaries of science.



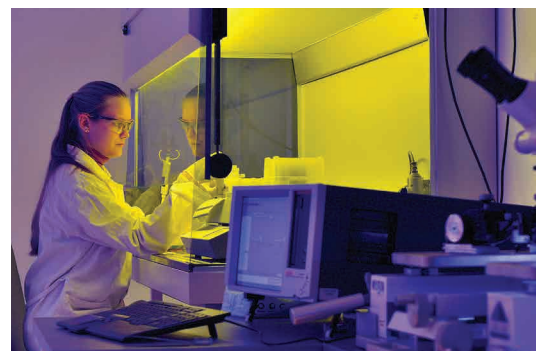
**Markus Dettenhofer**  
Executive Director



## 2.1 At a glance

### Central European Institute of Technology

CEITEC is a scientific centre in the fields of life sciences, advanced materials and technologies whose aim is to establish itself as a recognized centre for basic as well as applied research. CEITEC offers a state-of-the-art infrastructure and great conditions to employ excellent researchers. We are a consortium whose partners include the most important universities and research institutes in Brno, Czech Republic: Masaryk University, Brno University of Technology, Mendel University in Brno, Institute of Physics of Materials of the Academy of Sciences of the Czech Republic, University of Veterinary and Pharmaceutical Sciences Brno and the Veterinary Research Institute. We work closely with the Region of South-Moravia and the City of Brno to help increase the innovative capacity of the region.



### Vision

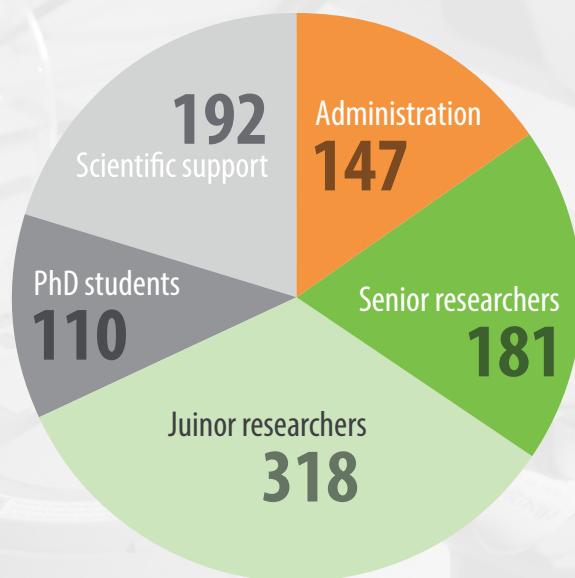
CEITEC will lead a path to global scientific recognition through science based on synergy and collaboration, in order to achieve a regional knowledge-based economy.

### Mission

CEITEC has been created to catalyse the existing basic and applied research in South Moravia to reach new levels. Its purpose is not only to provide its researchers with the best equipment and new laboratory facilities, but to engage in scientific discovery at a globally competitive level. To achieve this, CEITEC is aiming to retain and recruit scientifically talented people which can address important research questions. Development of PhD students and post-doctoral fellows for a future career in science or technologically demanding fields are important for the development of the region. By conducting research that bridges across technological disciplines, CEITEC will see its greatest advances that enhance the innovative environment of the region.

## 2.2 CEITEC in numbers

CEITEC employees	FTE	headcount
Senior researchers	91,55	181
Juinior researchers	152,20	318
PhD students	46,44	110
Scientific support	69,51	192
Administration	78,72	147
	<b>438,42</b>	<b>948</b>



### Foreign employees

Research programme	Long-term stay			Short-term stay			TOTAL
	EU	outside EU	=	EU	outside EU	=	
Advanced Nanotechnologies and Microtechnologies	4	4	8	0	0	0	8
Advanced Materials	2	0	2	0	0	0	2
Structural Biology	13	3	16	29	13	42	58
Genomics and Proteomics of Plant Systems	18	3	21	1	0	1	22
Molecular Medicine	2	1	3	0	2	2	5
Brain and Mind Research	1	1	2	0	1	1	3
Molecular Veterinary Medicine	0	2	2	0	0	0	2
CEITEC administration	0	1	1	0	0	0	1
<b>Sum total</b>	<b>40</b>	<b>15</b>	<b>55</b>	<b>30</b>	<b>16</b>	<b>46</b>	<b>101</b>

### Countries:

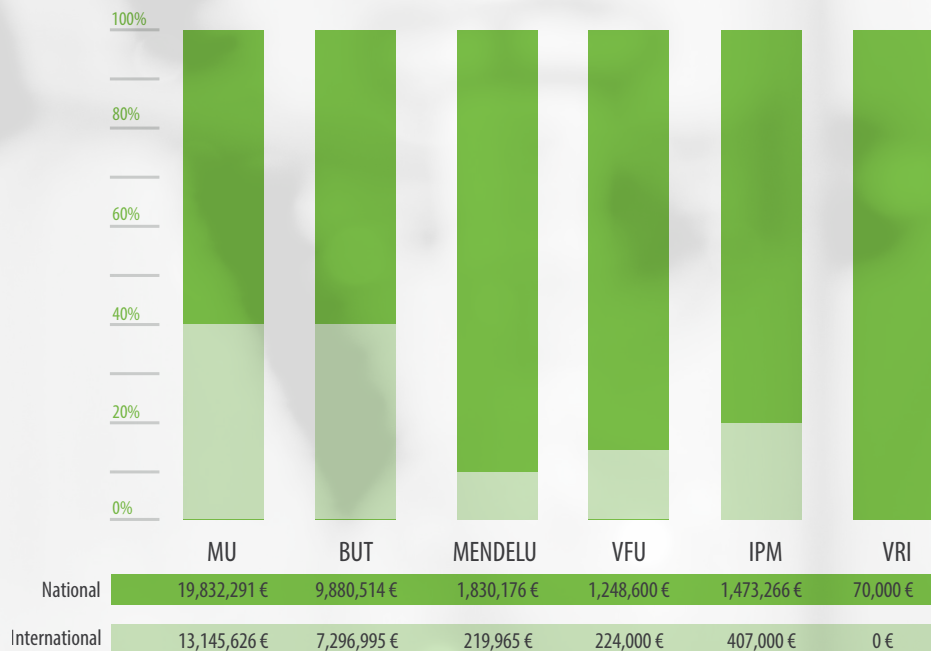
**EU (70):** Belgium (1), France(3), Italy (2), Lithuania (2), Hungary (10), Germany (5), Netherlands (1), Poland (10), Austria (3), Greece (4), Spain (8), Great Britain (2), Czech Republic reintegrating scientist (6)

**Outside EU (31):** Belarus (1), Ghana (1), India (11), Iran (1), Israel (1), Jordan (1), Russia (5), Serbia (1), Syria (1), Switzerland (3), USA (4), Vietnam (1)

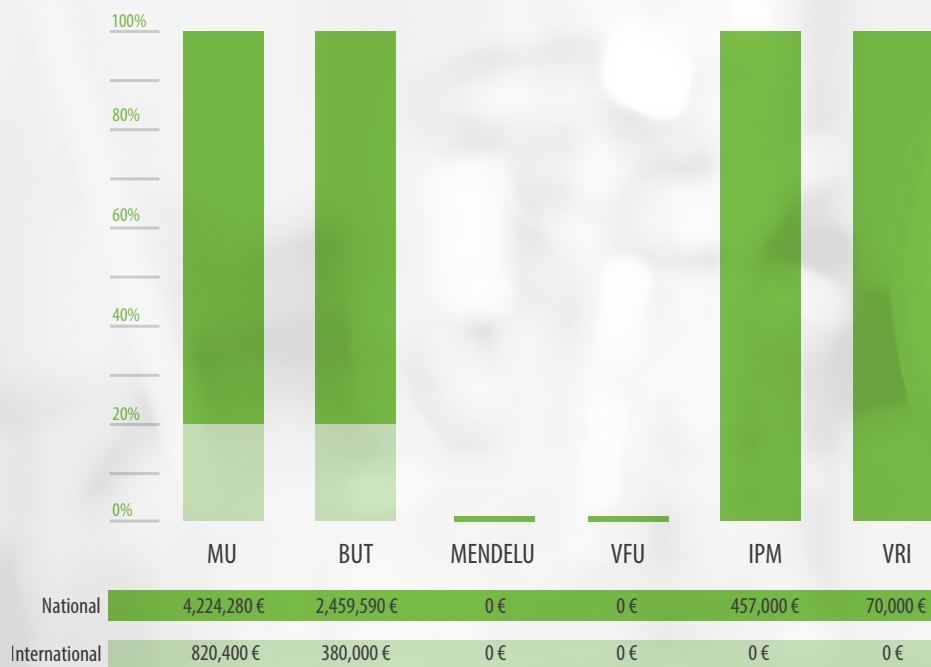




## Grants submitted in 2012 - share of national / international grants (%)



## Approved grants - submitted in 2012 - share of national / international grants (%)



Projects worth 12 668 189 € are still in evaluation as of 25<sup>th</sup> March 2013.

## 2.3 CEITEC buildings



A foundation stone laying ceremony took place on 26<sup>th</sup> September to officially launch the construction of CEITEC. The development takes place simultaneously on two sites in Brno: on the University Campus of Masaryk University (MU) in Bohunice, and on the Brno University of Technology (BUT) campus at Pod Palackého vrchem. Researchers will have moved into the new laboratories by the end of 2014.





Two new CEITEC buildings at MU with almost 7,000 m<sup>2</sup> of floor space for laboratories, training facilities and office space are under construction at University Campus Bohunice. The larger of the structures will feature an unusual elliptical layout and an inner roofed atrium. It will provide space for Research Programmes in Structural Biology, Genomics and Proteomics of Plant



Systems, Molecular Medicine, and Brain and Mind Research. The scientists will perform activities such as studying cancerous cells, developing methods for selecting healthy sperm and searching for causes of addiction, to name a few. The extended underground first floor will also contain a greenhouse and growth climate chambers known as phytotrons. The entire complex will contain seven core facilities with cutting-edge equipment such as nuclear magnetic resonance spectrometers used for the study the 3D structures of substances on an atomic level, and electron microscopes that enable the study of cell structures and other phenomena on a macromolecular level with very high resolution.

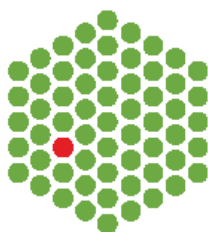
Four halls with a total area of 14,000 m<sup>2</sup> will be erected at the Pod Palackého vrchem BUT campus. They will house facilities for Research Programmes focusing on Advanced Materials and Advanced Nano- and Microtechnologies including three Core Facilities. Scientists will work on research projects such as the development of tooth or bone replacements made of polymers, nanochips, antibacterial surfaces and research robots. The construction project at CEITEC BUT is unique for the enormity of its “clean spaces”, which will encompass 1,050 m<sup>2</sup>. The strictest of standards in cleanliness will be met in more than 200 m<sup>2</sup>. People entering such areas are required to wear special gear including protective suits, facemasks, goggles, face guards and footwear. The technological equipment housed therein will allow for the production and testing of samples not visible with a normal microscope – their dimensions are a thousand times smaller than the diameter of a human hair.



### 2.3 Strategic partnerships

Strategic partnerships are part of a wider CEITEC internationalisation strategy. Strategic partnerships are concluded with leading international research institutions with the aim of teaming up with the best in class and improving science conducted within CEITEC. These partnerships involve various forms of cooperation – international mobility (exchanges of staff on all levels of seniority), joint research projects, organisation of conferences, workshops and summer schools, joint publications, joint/double Ph.D. degrees, use of CEITEC research infrastructure, etc.

#### CEITEC signed the Memorandum of Understanding with EMBL



Masaryk University, on behalf of the CEITEC, signed the Memorandum of Understanding on Scientific Collaboration with the European Molecular Biology Laboratory (EMBL). CEITEC is the only Czech institution having set up such an exclusive partnership with EMBL. Its aim is to develop cooperation between EMBL and the Czech Republic towards establishing the Czech Republic as an EMBL member, for which we are hopeful that this will be achieved in 2013, as well as enhancing cooperation

between CEITEC and EMBL. This cooperation includes such activities as training, in particular, in joint workshops; joint research projects, which may include scientific exchanges; participation in major conferences; cooperation in the field of major research infrastructure projects such as ELIXIR and EuroBioImaging; and the exchange of data on research performance.

#### CEITEC and Imperial College London become strategic partners



Imperial College London joined the family of CEITEC strategic partners over summer. A Memorandum of Understanding between the two parties was signed in August and covers the area of nanosciences and nanotechnologies. The leading person on the CEITEC side is Prof. Tomáš Šikola, Coordinator of the Advanced Nanotechnologies and Microtechnologies Research Programme and on Imperial side Prof. Stefan Maier, co-director of the Centre for Plasmonics and Metamaterials. The cooperation will result in joint research projects, training and academic exchanges of PhD students, PostDocs as well as faculty members and exchanges of expertise in the fabrication and characterisation of nanostructures.

Other Strategic Partners of CEITEC:

**Austrian Institute of Technology**  
**Elettra Synchrotron Light Laboratory**  
**ENMat – European Network of Materials Research Centres**  
**Université de la Méditerranée or Vienna University of Technology**



## 3.1 Research Discoveries & Awards

### Scientists from CEITEC MU unveil the mystery of déjà vu

Scientists from CEITEC MU and the Faculty of Medicine, Masaryk University have for the first time in history proved that the déjà vu phenomenon is linked to structures in the human brain and have unambiguously confirmed the neurological origin of this phenomenon. Their research proved that the déjà vu experience is directly influenced by particular brain structures.

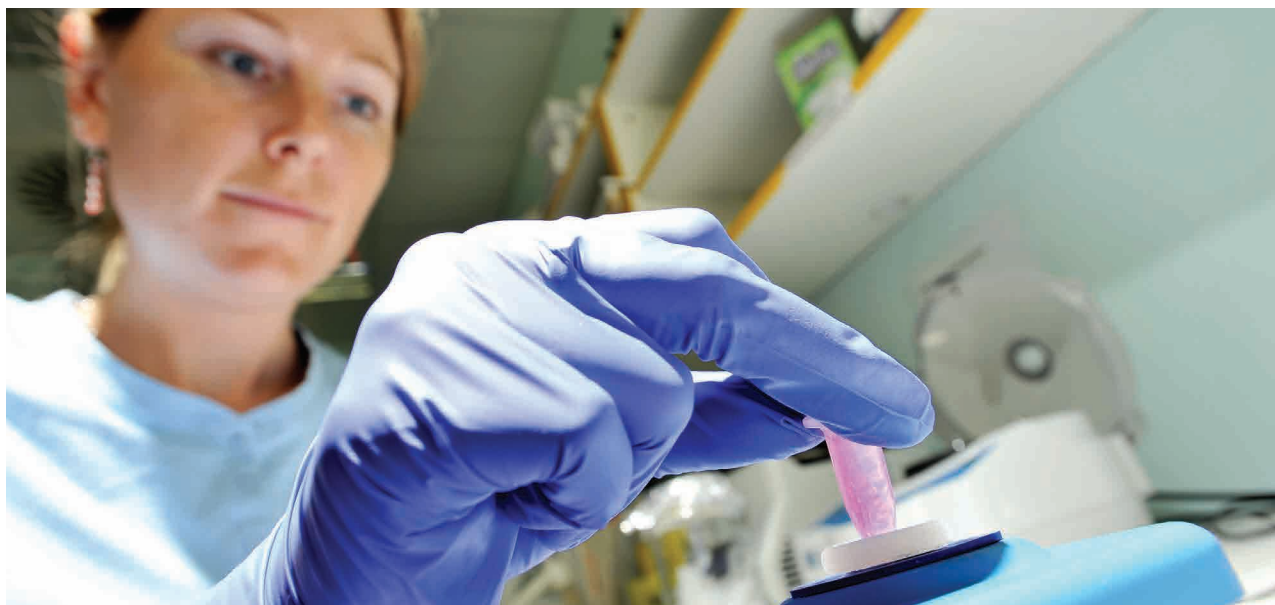


They found that these structures are significantly smaller in the brains of people experiencing déjà vu than in those who have had no personal experience with déjà vu. There had been no concrete proof to explain déjà vu in healthy individuals until now. Scientists from CEITEC MU and their colleagues from Brno and University of Exeter from the United Kingdom are the first in the world to prove such a connection. They have contributed significantly to unveiling the mystery of this phenomenon. Their research results were published by the prestigious scientific journal, *Cortex*, in April 2012.



## Significant progress in the research of leukemia was made by scientists from CEITEC

Experts from CEITEC MU and Faculty of Medicine, Masaryk University (LF MU), have discovered one of the significant factors that influences the origin and development of chronic lymphocytic leukemia. Their latest piece of published work is devoted to the role of a gene specified by microRNA-650, whose presence or increased activity is connected with a better prognosis and is also related to the development of the disease.



So far the discovery hasn't had a direct impact on the development of the treatment of the most common type of leukemia affecting the adult population in Europe, but it is an important step in finding out how the disease behaves and develops, which is the precondition for discovering an effective treatment. Scientists working at CEITEC and LF MU published the results of their research in the prestigious journal, *Blood*, published by the American Society of Hematology.

## EMBO Gold Medal 2012 recognises CEITEC researcher Jiří Friml

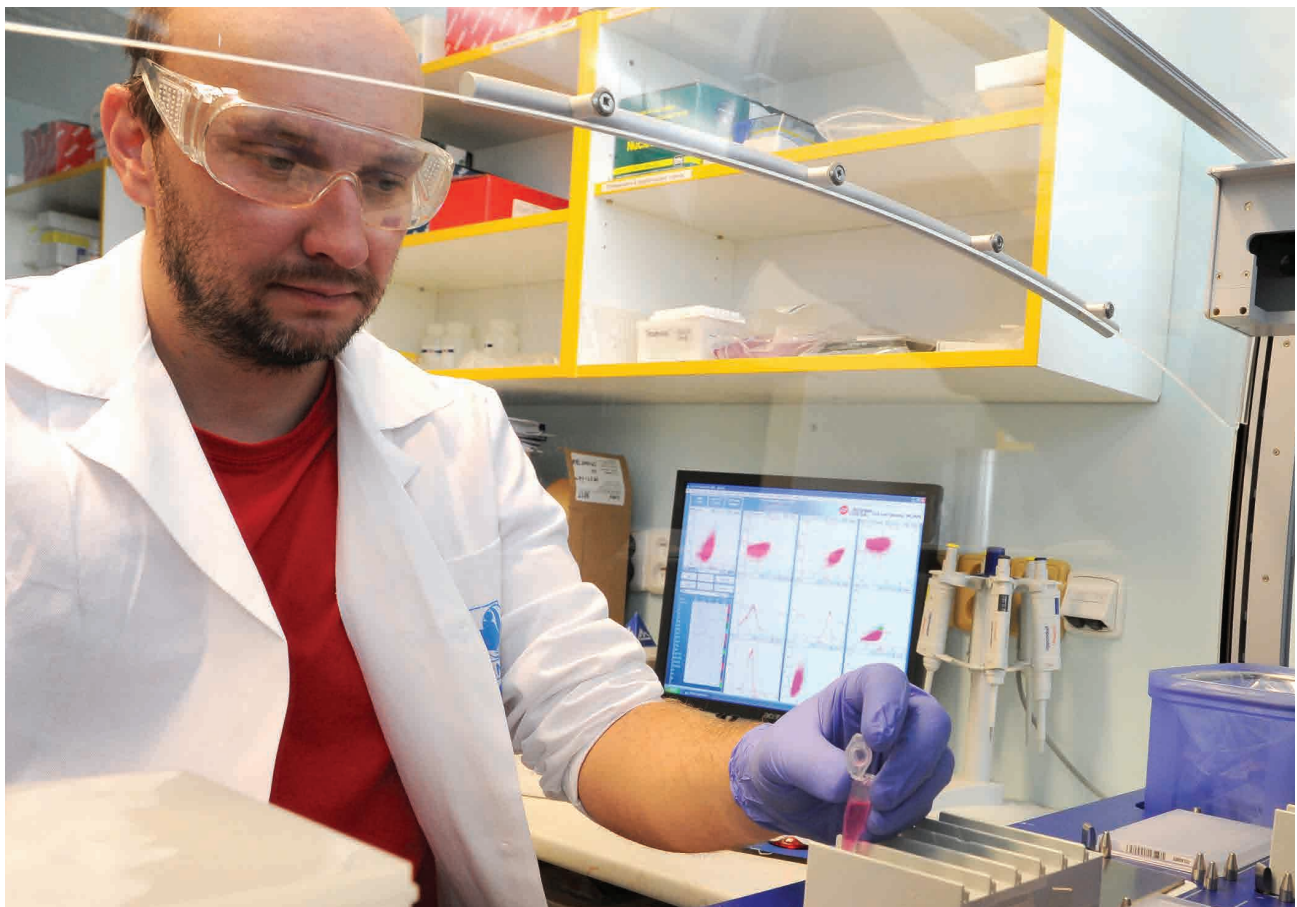
EMBO announced Jiří Friml of the Department of Plant Systems Biology, VIB and Ghent University, Belgium and CEITEC MU, Brno, Czech Republic as the winner of the 2012 EMBO Gold Medal. Friml receives the award for defining how the plant hormone auxin functions to regulate plant development. He was also recognized for showing how the auxin-governed molecular processes optimise adaptation of plant development and growth to ever-changing environmental conditions.

The 39-year-old scientist has published more than 130 original research publications and reviews in top international journals and belongs to the most cited plant biologists worldwide. The results of Friml's research are of a major importance to agriculture as they provide a basis for targeted engineering that could lead to the development of plants that produce higher yields or which are more resistant to drought.



## CEITEC scientist Boris Tichý receives the prestigious Discovery Award

The Discovery Award rewards young Czech scientists under 40 who conduct research in medicine and pharmaceuticals. On Wednesday 20<sup>th</sup> June, the results were announced and awards given for innovation for 2010 and 2011 at Charles University in Prague. Boris Tichý's team from CEITEC's Molecular Medicine Research Programme was one of three winners. The projects were assessed by a committee of eleven renowned experts who have been active a long time in the field of health services. Dr. Boris Tichý, Head of the Core Facility Genomics together with his team received the prize of 100,000 CZK for the project of improved molecular diagnostics and prognostic stratification of chronic lymphocytic leukemia and other lymphoproliferation. The following collaborators from the Molecular Medicine Research Programme are a part of the team: its Coordinator Prof. Šárka Pospíšilová, Prof. Michael Doubek and Dr. Jitka Malčíková.



## Lukáš Trantírek from CEITEC wins 2012 EMBO Installation Grant

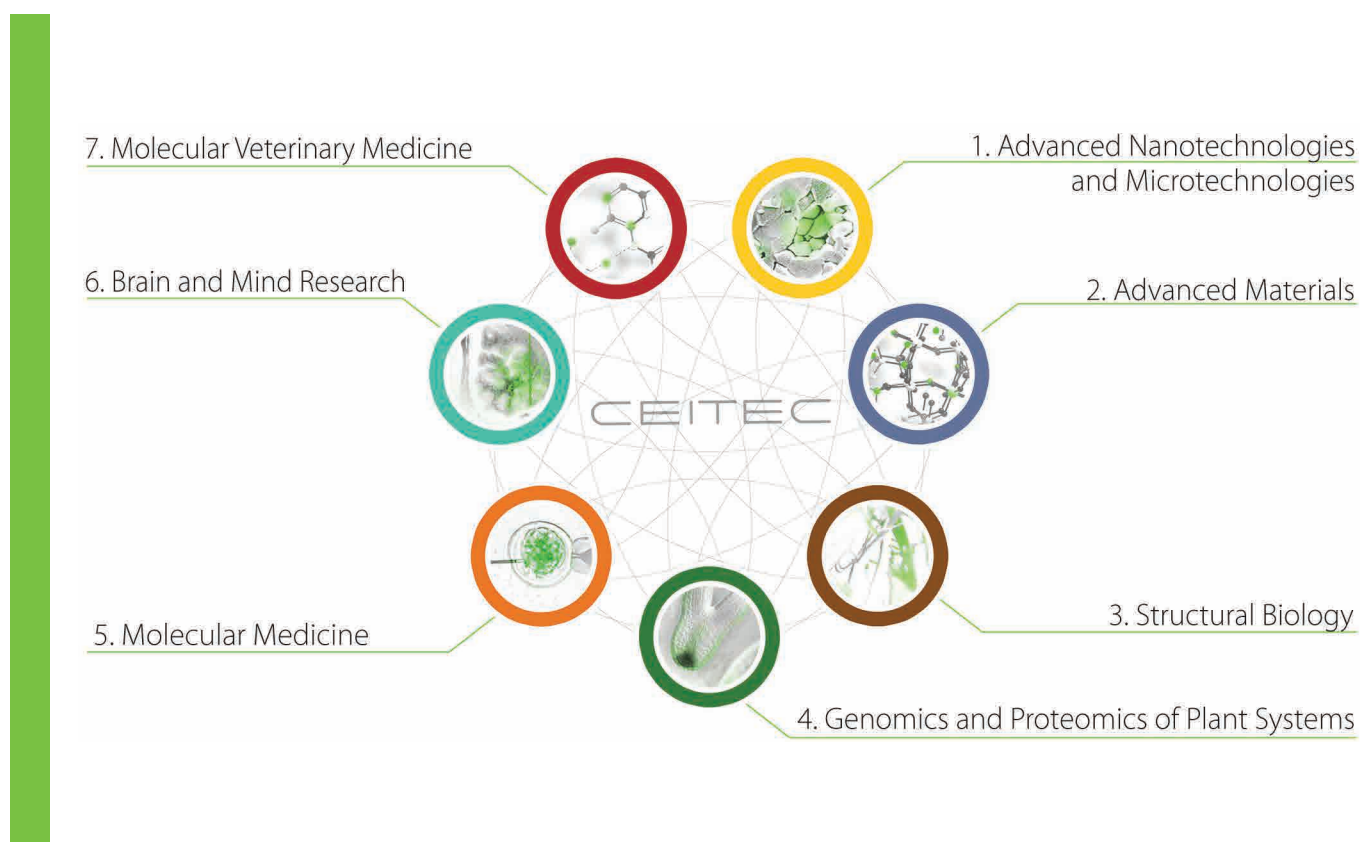
Lukáš Trantírek has won an EMBO Installation Grant and become the only Czech scientist to receive this grant in 2012. Once a year, EMBO, the European Molecular Biology Organization, awards grants to ten young scientists from the Czech Republic, Estonia, Poland, Portugal and Turkey. The EMBO Installation grant makes it possible for young scientists to become independent and set up their own research groups in their countries of origin.



The scientists selected for the grant receive awards from their host countries in the amount of 50,000 EUR per year for periods of three to five years. This facilitates the formation of their own scientific groups and their establishment in their respective scientific communities. As a result, the ten grant winners will become members of the prestigious network of EMBO Young Investigators, which enables them to more effectively integrate themselves and their new laboratories within the European scientific community. A total of fifty-eight researchers have received EMBO Installation Grants since the programme's inception in 2006.

## 3.1 Research Groups

The multi-departmental nature of CEITEC and the extent to which the fields of life sciences and advanced materials and technologies are integrated make it the first research centre of its kind in the Czech Republic. The high-tech technologies at its disposal will facilitate synergistic study in the subjects of life and material sciences on all currently available levels of complexity, starting with individual atoms, through molecules, molecule groups and cells to whole organisms.





# 1. Advanced Nanotechnologies and Microtechnologies

## Functional Properties of Nanostructures



**Josef Humlíček**  
Research Group Leader

### RESEARCH AREAS

- / Electronic and vibronic structure of materials and metamaterials
- / Optical spectroscopy and polarimetry of micro- and nanostructures
- / X-ray analysis of micro- and nanostructures

### MAIN OBJECTIVES

*Investigation of the functional properties of nanostructures*

- / Specification and optimization of the functional properties of nanostructures for nano-electronics, nanophotonics and (bio)sensing, their correlation with geometrical/structural parameters of nanostructures and operational parameters.
- / Novel and unique properties of nanostructures not observable in conventional materials and microstructures which open ways to qualitatively new applications.
- / Physical properties of bulk materials, mainly those involved in the nanostructures.

## Smart Nanodevices



**Jaromír Hubálek**  
Research Group Leader

### RESEARCH AREAS

- / Miniaturized systems
- / Nanostructures and nanoparticles
- / Nanomedicine
- / Nanomachinery, nanorobots and nanotransporters

### MAIN OBJECTIVES

- / Focus on several areas of research covering modern electrochemical methods, synthesis of nanometrials such as quantum dots and magnetic nanoparticles, nanomedicine and targeted therapy as well as miniaturized devices for sensing and electronics including nonoelectrodes, nanopotentiostats, MEMS and Lab on a Chip.
- / Application of 3D printing in nanotechnology and nanomedicine is at the centre of our interest.
- / Development of methods, techniques and technology for implementation of outputs into advance nanodevices and nanoprobes for electronics, nanomedicine and drug delivery is the main goal.

## Experimental Biophotonics



**Radim Chmelík**  
Research Group Leader

### RESEARCH AREAS

- / Advanced light (holographic, multimodal) microscopy (ALM) – innovative technologies
- / Evaluation of live cell behaviour using ALM
- / Analysis of micro- and nanostructures using ALM

### MAIN OBJECTIVES

*Research and development of analytical and measurement methods*

- / Focus on advanced light microscopy techniques and methodologies applied to the study of nano- and microstructures characteristics and interactions with living cells including assessments of possible cytotoxicity and cancer cell diagnostics.

## Fabrication and Characterisation of Nanostructures



**Tomaš Šíkola**  
Research Group Leader

### RESEARCH AREAS

- / Fabrication of nanostructures using bottom-up methods
- / Fabrication of nanostructures using top-down methods (nanolithography)
- / Investigation of the functional properties of nanostructures
- / The development of analytical and measurement methods

### MAIN OBJECTIVES

*Fabrication of nanostructures using bottom-up and top-down methods (nanolithography)*

/ Development of methods for the fabrication of nanostructures: planar physical and plasmachemical methods using EBL, UV lithography, FIB, SPM lithography, and imprint technology. MBE, CVD, ALD, PECVD, hybrid methods for selective growths, etc.

*Investigation of the functional properties of nanostructures*

/ Specification and optimization of the functional properties of nanostructures for nanoelectronics, nanophotonics and (bio)sensing their correlation with geometrical/ structural parameters of nanostructures and operational parameters

*Research and development of analytical and measurement methods*

/ Development of techniques and methodologies for microscopy, analysis and metrology of nanomaterials/nanostructures, and for diagnostics of their properties – new techniques of nanometrology by SPM, optical methods, combination of more techniques (SEM, AFM, etc.).

## Development of Methods for Analysis and Measuring Nanostructures



**Petr Klapetek**  
Research Group Leader

### RESEARCH AREAS

- / Quantitative scanning probe microscopy
- / Metrology
- / Numerical methods in nanoscale metrology

### MAIN OBJECTIVES

*Research and development of analytical and measurement methods*

/ Development of the techniques and methodologies for microscopy, analysis and metrology of nanomaterials/nanostructures, and for diagnostics of their properties – new techniques in nanometrology with SPM, optical methods, and combinations of other techniques (SEM, AFM, etc.).

# 1. Advanced Nanotechnologies and Microtechnologies

## X-ray Micro CT and Nano CT



**Jozef Kaiser**  
Research Group Leader

### RESEARCH AREAS

- / Development and application of micro and nano- radiography and computed tomography ( $\mu$ CT, nanotCT) techniques in different fields
- / High-resolution 3D metrology
- / Combination of micro- and nanoradiography and  $\mu$ CT, nanotCT techniques with other analytical approaches, e.g. with Laser-Induced Breakdown Spectroscopy (LIBS)

### MAIN OBJECTIVES

*Research and development of analytical and measurement methods*

- / Development of techniques and methodologies for microscopy, analysis and metrology of nanomaterials/nanostructures, and for diagnostics of their properties – new nanometrology techniques using SPM, optical methods, and combinations of other techniques (SEM, AFM, etc.).

## Optoelectronic Characterisation of Nanostructures



**Lubomír Grmela**  
Research Group Leader

### RESEARCH AREAS

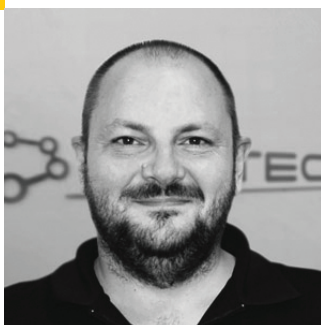
- / The participation of the Optoelectronic Characterization of Nanostructures group at CEITEC will make it possible to carry out research on local electric and optical parameters of nanomaterials with high resolution suitable for advanced semiconductor devices and materials.

### MAIN OBJECTIVES

*Investigation of functional properties of nanostructures*

- / Specification and optimization of the functional properties of nanostructures for nanoelectronics, nanophotonics and (bio)sensing, their correlation with structural and operational parameters of nanostructures.
- / Novel and unique properties of nanostructures, not observable in conventional materials and microstructures, which open ways to qualitatively new applications.

## Micro and Nanotribology



**Ivan Krupka**  
Research Group Leader

### RESEARCH AREAS

- / Experimental study of molecular degradation of lubricants
- / Real roughness behaviour within lubricated contacts
- / Thin-film-lubrication studies under non-steady-state conditions
- / Effect of proteins in biotribology applications

### MAIN OBJECTIVES

*Research and development of analytical and measurement methods*

- / Development of techniques and methodologies for microscopy, analysis and metrology of tribological properties of surfaces and protective layers – new techniques of nanometrology with SPM, optical methods, combinations of other techniques (SEM, AFM, etc.).



## Plasma Technologies



**Lenka Zajíčková**  
Research Group Leader

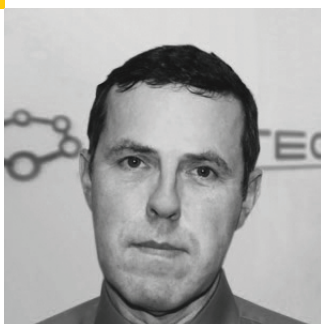
### RESEARCH AREAS

- / Plasma processing of materials, plasma diagnostics and simulations
- / Functional coatings, materials for sensors, biomaterials
- / Methods for characterization of optical and mechanical properties
- / Software for scanning probe microscopy (SPM) data visualization and analysis

### MAIN OBJECTIVES

- / Development of low and atmospheric pressure plasma processes for the deposition of thin films, preparation of nanostructured materials, plasma (co)polymerization and plasma etching.
- / Plasma modification of metal, glass and polymer surfaces for additional functionality.
- / Understanding the interaction of plasma with surfaces and the relation of plasma parameters to the properties of resulting materials.

## Synthesis and Analysis of Nanostructures



**Jiří Pinkas**  
Research Group Leader

### RESEARCH AREAS

- / Nonhydrolytic sol-gel syntheses of porous metal oxides, phosphates, silicates, metallo-organic coordination polymers and frameworks, molecular building blocks for metallo-phosphate materials
- / Sonochemical synthesis of binary and ternary metal oxide nanoparticles and precipitation of nuclear waste forms
- / Nanoparticles of metals and alloys as lead-free solders, calculation and verification of their phase diagrams
- / Theoretical studies of structural, magnetic, thermodynamic properties of inter-metallic phases, magnetism of grain boundaries

### MAIN OBJECTIVES

#### *Fabrication of nanostructures using "bottom-up" methods*

- / Nonhydrolytic sol-gel syntheses of nanoporous metal oxides, phosphates, and silicates.
- / Synthesis and assembly of molecular building blocks into new materials.

#### *Investigation of the functional properties of nanostructures*

- / Characterization and optimization of the functional properties of nanostructures for catalysis, nanoelectronics, nanophotonics and (bio)sensing; and their correlation with compositional, morphological, and structural parameters.

#### *Research and development of submicron devices and nanostructures*

- / Development of methods and techniques into higher functional integrated systems, optimized nanocatalysts, soldering formulation based on nanoalloy particles, nano- and micro-analytical systems and sensors and advanced materials for them.

#### *Research and development of analytical and measurement methods*

- / Development of the techniques and methodologies for analysis of nanomaterials/nanostructures and for diagnostics of their properties – new techniques of elemental mapping, microanalysis, MS surface imaging, medical diagnostics, and biosensing.

# 1. Advanced Nanotechnologies and Microtechnologies

## Transport and Magnetic Properties



**Bohumil David**

Research Group Leader

### RESEARCH AREAS

/ Experimental investigations into relationships between structure and magnetic, transport and mechanical properties in metallic materials  
/ Theoretical studies of electronic and magnetic properties of disordered alloys, epitaxial multilayers, surfaces and interfaces as well as quantum-mechanical studies of extended defects in metallic materials

### MAIN OBJECTIVES

*Investigation of the functional properties of nanostructures*

/ Specification and optimization of the functional properties of nanostructures for nanoelectronics, nanophotonics and (bio)sensing, their correlation with geometrical/structural parameters of nanostructures and operational parameters. Novel and unique properties of nanostructures not observable in conventional materials and microstructures open ways to qualitatively new applications.

# 2. Advanced Materials

## Advanced Ceramic Materials



**Jaroslav Cihlár**

Research Group Leader

### RESEARCH AREAS

/ Biomaterials  
/ Materials for energetics and ecology  
/ Structural materials

### MAIN OBJECTIVES

*Biomaterials*

/ The development of novel composite biomaterials that can induce the growth of connective tissue on the surface of implants and thus accelerate healing and improve the strength and biological stability of the implant-tissue connection

*Materials for energetics and ecology*

/ The development of novel composite materials with functionally graded structures for improving the efficiency and lifetimes of components and devices for energetics

*Structural materials*

/ The development of novel ceramics and ceramic composites with excellent mechanical and thermal properties for structural applications

### Materials for Sensors and Technological Processes Control Systems



**Pavel Václavek**

Research Group Leader

#### RESEARCH AREAS

- / Smart sensors and signal processing, sensor design using new materials
- / Advanced control technologies, control of technological processes
- / Mobile robotic systems
- / Embedded systems and communication technologies

#### MAIN OBJECTIVES

- / The development of novel composite materials with functionally graded structures for improving the efficiency and lifetimes of components and devices for energetics, communication and control technologies (conductive ceramic and polymer materials for electrodes, novel actuators, sensor components, control and instrumentation systems for technological processes, catalyst for the decomposition of gaseous pollutants, biopolymers and precursors from plants and plant residues).

### Advanced Polymers and Composites



**Josef Jančář**

Research Group Leader

#### RESEARCH AREAS

- / Synthesis of specialty organic and organic-inorganic polymers and copolymers
- / Multi-scale structure-property relationships in polymers and polymer composites
- / Development of advanced functional materials based on nanostructured hierarchical polymers
- / Syntheses of controlled life-span polymers, resorption of biomedical polymers, service life-time period predictions for commodity plastics
- / Physics of heterogeneous polymer systems, deformation and fracture phenomena in polymers reptation dynamics, nanocomposite viscoelasticity, self-assembly
- / Synthesis of biopolymeric materials for tissue engineering and drug delivery

#### MAIN OBJECTIVES

##### *Biomaterials*

- / The development of novel composite biomaterials that can induce the growth of connective tissue on the surface of implants and thus accelerate healing and improve the strength and biological stability of the implant-tissue connection

##### *Materials for energetics and ecology*

- / The development of novel composite materials with functionally graded structures for improving the efficiency and lifetimes of components and devices for energetics, communication and control technologies

##### *Structural materials*

- / The development of novel ceramics and ceramic composites with excellent mechanical and thermal properties for structural applications



### Advanced Metallic Materials and Metal Based Composites



**Research Group Leader is to be appointed**

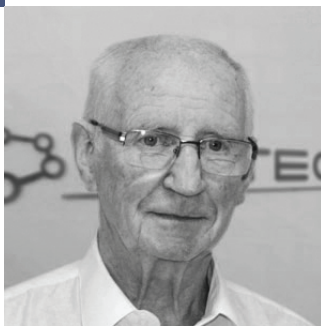
#### RESEARCH AREAS

- / Basic mechanisms of creep, fatigue, brittle fracture and their combination in relation to microstructure of metallic materials and metal-based composites.
- / Theoretical studies of crack behaviour in metallic materials, metal-based composites and components.
- / Multi-scale simulation of deformation and fracture processes, quantitative fractography and prediction of fatigue life under multiaxial loading.
- / Solutions to problems related to fatigue, creep and brittle fracture of both currently applied and developed materials in industrial applications.

#### MAIN OBJECTIVES

- / To study the relationship between material structures and material properties, mainly mechanical.
- / The research is aimed at fatigue, creep, their interaction, and fracture properties of advanced materials and metal based composites used or currently being developed for application in energetics, transport and medicine.

### Structure and Phase Analysis



**Jiří Švejcar**  
Research Group Leader

#### RESEARCH AREAS

- / Specialised service in the area of electron microscopy, microanalysis and x-ray diffraction for all research groups of CEITEC and also outside the CEITEC
- / Composites on metallic matrices
- / Ultra-fine grain materials
- / Nanostructured plasma coatings

#### MAIN OBJECTIVES

- / To establish The Structural Analysis Laboratory Core Facility for advanced structural and composition studies equipped with a transmission electron microscopy, scanning electron microscopy and x-ray diffraction analysis.
- / By means of specialised service in the area of the structural and composition analyses this research group will participate in the research of biomaterials, materials for energetics, communication, ecology and structural materials which will carry out other research groups of CEITEC.

## Bioinformatics



**Hedi Hegyi**

Research Group Leader

### RESEARCH AREAS

- / Computational analysis and prediction of the viability of alternatively spliced proteins with truncated globular domains
- / Sequence analysis and census of alternatively spliced proteins in the human genome and various human tissues, including different brain compartments
- / Repetitive elements in the human genome and their role in regulatory functions

### MAIN OBJECTIVES

- / Investigation of normal (tissue-specific) and aberrant (cancer-related) alternative splicing, with special respect to the viability of splice variants on the protein level
- / Delineating Pfam domain use in healthy and diseased tissues
- / Sequence analysis of schizophrenia-related genes and genomic regions. Possible implications with respect to the cause of the disease.

## CD spectroscopy of Nucleic Acids and Proteins



**Michaela Vorlíčková**

Research Group Leader

### RESEARCH AREAS

- / Studies in the conformational properties of genomic DNA fragments important from biological and medical points of view
- / Investigations into the structures and interactions of biomacromolecules and how they relate to the functions of living systems, diseases and therapies

### MAIN OBJECTIVES

- / To map the conformational properties of DNA sequence motifs occurring in important regions of the human genome.
- / To characterize the physico-chemical properties of non-B DNA structures, chemical alterations in DNA, and other external factors affecting their stability, dynamics and recognition by proteins.

## CryoEM



**Jürgen Plitzko**

Research Group Leader

### RESEARCH AREAS

- / Structure and function of macromolecular complexes and cellular assemblies.
- / Molecular mechanisms of virus replication and host-pathogen interactions.
- / Time-resolved electron microscopy of biological processes at millisecond timescale.

### MAIN OBJECTIVES

- / Investigate the structure, interactions and conformational dynamics of macromolecular complexes and assemblies to understand the structural basis of their function and regulation.
- / Elucidate the structural and conformational features of viral capsids to understand the molecular mechanisms of virus assembly, maturation and interaction with the host cell.
- / Develop and apply new methods of time resolved cryo-electron microscopy to study assembly and conformational dynamics of transient macromolecular complexes.

## Glycubiochemistry



**Michaela Wimmerová**  
Research Group Leader

### RESEARCH AREAS

- / Carbohydrate-binding proteins involved in host-pathogen interactions
- / Human glycosyltransferases and their role in cancerogenesis
- / Glycosyltransferases participating in mycobacterial cell wall synthesis
- / Protein engineering of lectins
- / Biomolecular interactions

### MAIN OBJECTIVES

- / To study the therapeutical aspects of recognition and adhesion phenomena in host-pathogen interactions.
- / Investigations of the structures and interactions of biomacromolecules and their relations to the functions of living systems, disease and therapy.

## RNA Quality Control



**Štěpánka Vaňáčová**  
Research Group Leader

### RESEARCH AREAS

- / Mechanisms of nuclear RNA surveillance
- / Mechanisms and function of noncanonical polyadenylation
- / RNA degradation

### MAIN OBJECTIVES

- / Investigation of the role of RNA in development and human diseases.
- / Biochemical and structural characterization of RNA in eukaryotic cells.

## Nanobiotechnology



**Petr Skládal**  
Research Group Leader

### RESEARCH AREAS

- / Imaging of biomolecules, cells and other biological objects using scanning probe microscopies (SPM – including AFM, SNOM and STM)
- / Characterization of affinity interactions using biosensors in real time
- / Development of biosensors using electrochemical, optical and piezoelectric transducers
- / Immobilization, modification and conjugation of biomolecules

### MAIN OBJECTIVES

- / Visualization and modification of biological objects including tissues, cells, cellular structures, and single biomolecules
- / Development of new methodologies for investigating the structure, interactions, and dynamics of biomolecules.
- / Investigations into the structure and interactions of biomacromolecules and their relation to the functions of living systems, disease and therapy.
- / Investigations into the behaviour of natural and chemically modified biomacromolecules at electrically charged surfaces linked to the development of novel electrochemical biosensors and bioassays.



## Biomolecular NMR Spectroscopy



**Vladimír Sklenář**  
Research Group Leader

### RESEARCH AREAS

- / NMR methodology (fast acquisition, non-linear sampling, C-13 detection)
- / 3D structure determination of proteins and nucleic acids from NMR measurements
- / Relaxation studies of biomolecular dynamics in complex systems
- / Structural characterization of small, biologically interesting molecules
- / Ab initio calculations of NMR parameters

### MAIN OBJECTIVES

- / Development of new methodologies for investigating the structures, interactions, and dynamics of biomolecules.
- / Investigations into the structure and interactions of biomacromolecules and how they relate to the functions of living systems, diseases and therapies.

## RNA-based Regulation of Gene Expression



**Peter Lukavsky**  
Research Group Leader

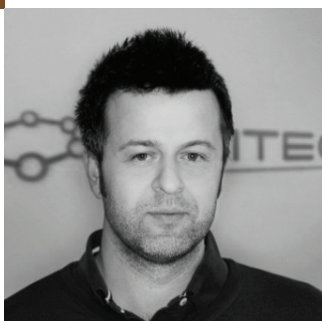
### RESEARCH AREAS

- / Molecular principles of posttranscriptional regulation of gene expression through alternative splicing, RNA transport and translational control
- / 3D structure determination of large RNAs and RNA-protein complexes by solution NMR spectroscopy
- / Biochemical and biophysical studies of RNA-protein interactions
- / Development of novel purification methods and isotope labelling schemes for NMR studies of large RNAs and their assemblies

### MAIN OBJECTIVES

- / Molecular basis of spatial and temporal control of gene expression through directed RNA transport in dendrites and during development
- / Investigation of molecular principles of RNA-protein interaction networks regulating alternative mRNA splicing of disease-related genes
- / Advancing the size of RNAs and their assemblies amenable to solution NMR studies

## Structural Biology of Gene Regulation



**Richard Štefl**  
Research Group Leader

### RESEARCH AREAS

- / Protein-RNA and protein-protein interactions and their roles in the regulation of gene expression
- / 3'-end processing and transcription termination
- / NMR spectroscopy of proteins and nucleic acids and their complexes
- / Development and application of new methods to aid the interpretation of NMR data

### MAIN OBJECTIVES

- / Investigation of the role of RNA in gene expression, development and human diseases.
- / Establishing an isotope laboratory for NMR studies and the development of new strategies for the preparation of isotopically labelled proteins in eukaryotic cells.

## Structural Virology



**Pavel Plevka (TBC)**  
Research Group Leader

### RESEARCH AREAS

- / X-ray crystallography of proteins, macromolecular complexes, and icosahedral viruses.
- / Cryo-electron microscopy and single particle reconstruction of viruses in complexes with antibodies or cellular receptors.
- / Cryo-electron tomography of virus assembly and cell entry intermediates.

### MAIN OBJECTIVES

- / Obtain structural understanding of virus life-cycles and use it to develop anti-viral therapies.

## Structure and Dynamics of Nucleic Acids



**Jiří Šponer**  
Research Group Leader

### RESEARCH AREAS

- / Studies of structure, dynamics and molecular interactions of nucleic acids and their complexes with proteins using explicit solvent molecular dynamics simulations; main attention is paid to functional RNAs, such as ribosomal RNAs and catalytic RNAs
- / Studies of canonical and noncanonical DNA molecules
- / Quantum chemical modelling of processes relevant to the prebiotic synthesis of nucleic acid components
- / Structural bioinformatics of RNA (classification of molecular interactions in nucleic acids based on structural and sequence data)
- / Testing and refinement of force fields for atomistic simulations of nucleic acids
- / Reference quantum-chemical calculations of molecular interactions and conformational substates in nucleic acids

### MAIN OBJECTIVES

- / Investigation of the role of RNA and DNA in development and human diseases.
- / Development of new methodologies for investigating the structure, interactions, and dynamics of biomolecules.

## Structure and Interactions of Biomolecules at Surfaces



**Miroslav Fojta**  
Research Group Leader

### RESEARCH AREAS

- / Interactions of natural and chemically modified biopolymers with electrodes, relationships between biopolymer structure and its electrochemical, interfacial and electrocatalytic properties
- / Novel techniques in biopolymer labelling
- / Effects of DNA and/or protein chemical modification on the biopolymer molecular recognition features
- / Development of novel bioanalytical/bioelectroanalytical and diagnostic tools

### MAIN OBJECTIVES

- / Investigations into the behaviour of natural and chemically modified biomacromolecules at electrically charged surfaces linked to the development of novel electrochemical biosensors and bioassays.
- / Development of novel electrochemical biosensors, bioassays and diagnostic approaches.

## Computational Chemistry



**Jaroslav Koča**  
Research Group Leader

### RESEARCH AREAS

- / Structure and dynamics of proteins, nucleic acids, saccharides, and their complexes
- / Enzymatic reactions
- / Chemoinformatics and bioinformatics
- / Structure and dynamics of supramolecular complexes

### MAIN OBJECTIVES

- / To study the therapeutical and bioanalytical aspects of recognition and adhesion phenomena in host-pathogen interactions.
- / To develop new methodologies for investigating the structure, interactions, and dynamics of biomolecules.

# 4. Genomics and Proteomics of Plant Systems

## Bioanalytical Instrumentation



**František Foret**  
Research Group Leader

### RESEARCH AREAS

- / Capillary separations
- / Mass spectrometry coupling
- / Miniaturisation
- / Single cell analysis

### MAIN OBJECTIVES

- / Development of novel techniques for the separation and analysis of nucleic acids, proteins, small bio active molecules & drugs and their complexes based on electrophoretic and microfluidic systems, electrochemical and optical methods and nanotechnologies.



## Plant Cytogenomics



**Martin Lysák**  
Research Group Leader

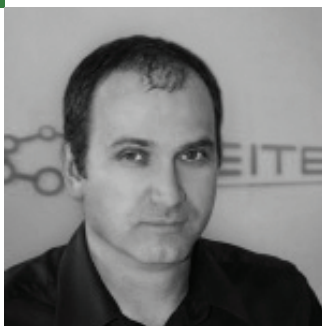
### RESEARCH AREAS

- / Karyotype and genome evolution in plant
- / Chromosome rearrangements in speciation
- / Whole-genome duplications (polyploidy)
- / Chromosome structure
- / Evolution of repetitive DNA
- / Comparative and evolutionary phylogenomics
- / Molecular phylogenetics

### MAIN OBJECTIVES

- / Investigation into the evolution of chromosome complements (karyotypes) in land plants.
- / Understanding the role of chromosome repatterning and whole-genome duplication events in genome evolution and speciation.
- / Analysis of chromosome and genome collinearity using comparative molecular cytogenetics and sequence genomics methods.

## Functional Genomics and Proteomics of Plants



**Jan Hejátko**  
Research Group Leader

### RESEARCH AREAS

- / Role of cytokinins in the vascular tissue and root apical meristem formation and development
- / Interaction of cytokinin and other hormones, particularly auxin
- / Interaction of cytokinins with light
- / Structural basis of multistep phosphorelay signaling in plants
- / Plant proteome and phosphoproteome response to cytokinins
- / Employing the knowledge of molecular mechanisms of multistep phosphorelay-based signalling in molecular breeding
- / Production of bioactive compounds in plant production systems

### MAIN OBJECTIVES

- / Determination of molecular mechanisms governing hormonal regulations and their functions in plant development.

## Hormonal Crosstalk in Plant Development



**Eva Benková**

Research Group Leader

### RESEARCH AREAS

- / Growth and development of plants are regulated by signalling substances such as plant hormones. In plants, interactions between hormonal pathways represent crucial factors that govern their action. The molecular basis for hormonal crosstalk is largely unknown.
- / Research group aims to identify the molecular and cellular mechanism(s) underlying crosstalk of hormonal pathways in organogenesis and other plant developmental processes.
- / Research group uses lateral root formation in Arabidopsis as an ideal experimental model to study mechanisms of plant hormone action, the molecular basis of their interactions, and the role of these interactions in organogenesis.

### MAIN OBJECTIVES

- / Convergence of hormonal pathways on transport-dependent auxin distribution upstream of lateral root formation
- / Role of auxin-cytokinin interaction in lateral root formation
- / Identification of components of hormonal crosstalk by genetic approaches
- / Formulation of general models for hormonal regulation of organogenesis

## Metabolomics



**Zdeněk Glatz**

Research Group Leader

### RESEARCH AREAS

- / Metabolomics
- / Metabolism
- / Metabolites
- / Biomarkers
- / Drug metabolism
- / Nuclear magnetic resonance
- / Mass spectrometry
- / Liquid chromatography
- / Gas chromatography
- / Capillary electrophoresis

### MAIN OBJECTIVES

- / Using bacterial metabolomics as a model for systems biology.
- / Establishing metabolite biomarkers for diagnostics.
- / Development of a miniaturised drug metabolism system based on capillary electrophoresis.

## Proteomics



**Zbyněk Zdráhal**

Research Group Leader

### RESEARCH AREAS

- / Separation of complex protein mixtures
- / Characterization of proteins and their modifications by mass spectrometry
- / Mass spectrometric techniques for the quantification of protein mixtures
- / MS-based proteomics in general

### MAIN OBJECTIVES

- / The development of novel techniques for the separation and characterization of proteins using mass spectrometry.

## Developmental and Cell Biology of Plants



**Jiří Friml**

Research Group Leader

### RESEARCH AREAS

- / Focus on how different environmental and endogenous signals are integrated into the subcellular dynamics and polar localisation of transporters for plant hormone auxin. We expect to get a deeper knowledge on plasticity of plant responses to environmental cues.

### MAIN OBJECTIVES

- / Plant hormonal signalling for regulation of cell polarity and subcellular dynamics
- / Cell polarity and subcellular dynamics in plant cells
- / Perception of external signals and their integration into subcellular dynamics and cell polarity
- / Integration of hormonal signalling and subcellular dynamics for multicellular tissue development by mathematical modelling



## Chromatin Molecular Complexes



**Jiří Fajkus**

Research Group Leader

### RESEARCH AREAS

- / Structure, evolution and maintenance of telomeres and their roles in chromosome stability and plant speciation; this includes the characterization of nucleoprotein composition of telomeres and telomerases, biophysical analysis of interactions between telomere components by quantitative methods, analysis of structure-function relationships of telomerase subdomains and analysis of alternative (telomerase independent) strategies of telomere maintenance
- / Epigenetic mechanisms in the regulation of gene expression, chromosome stability and telomere homeostasis
- / Structure, evolution and functions of SMC complexes; the characterization of SMC5-6 complex subunits and MAGE proteins in vitro and in vivo; their roles in DNA repair and chromosome dynamics

### MAIN OBJECTIVES

- / Structure, evolution, maintenance and epigenetic regulations of telomeres and their roles in chromosome stability and plant speciation. Epigenetic regulations.

## Developmental and Production Biology – Omics Approaches



**Břetislav Brzobohatý**

Research Group Leader

### RESEARCH AREAS

- / Molecular mechanisms underlying:
  1. hormonal regulation of plant development
  2. plant adaptation to abiotic and biotic cues
- / Molecular markers related to economically important traits

### MAIN OBJECTIVES

- / Determination of molecular mechanisms governing hormonal regulations and their functions in plant development and stress-response.
- / Developmental outputs of cell polarity will be established.

## Plant Stress Signalling and Adaptation



**Vanesa Beatriz Tognetti**

Research Group Leader

### RESEARCH AREAS

- / ROS-auxin crosstalk regulatory network underlying plant stress adaptation
- / Plastid ROS-redox signaling on the response of plants to stress and on hormone homeostasis
- / Stress-perturbed auxin signaling on photosynthesis modulation

### MAIN OBJECTIVES

- / To decipher how environmental and developmental signals are integrated by ROS-auxin crosstalk
- / To unravel how the interaction between ROS and hormones synchronizes stress-induced growth reorientation and photosynthetic performance, which are vital for plant survival
- / Discovery of stress avoidance genes and new stress tolerance strategies to improve crop performance under changing global conditions

## Medical Genomics



**Šárka Pospíšilová**  
Research Group Leader

### RESEARCH AREAS

- / Introduction of high-throughput analyses into medical research and diagnostics, development of new diagnostic techniques
- / Identification and analysis of novel diagnostic and prognostic markers and therapeutic targets

### MAIN OBJECTIVES

- / Introduction of high-throughput analyses of human genomes (whole genome/exom sequencing, transcriptome profiling, microRNA detection, SNP analysis, etc.). Utilization of these technologies in medicine and development of diagnostic tests based on high-throughput methods
- / Mutational analyses of human cells in relation to cancer, neuromuscular, neurodegenerative, metabolic and skin disorders; the detection of novel prognostic markers

## Molecular Oncology I - Hematooncology



**Martin Trbušek**  
Research Group Leader

### RESEARCH AREAS

- / Role of tumour suppressor p53 in cancer
- / Pathogenesis and therapy of chronic lymphocytic leukemia
- / Drug testing on cancer cells

### MAIN OBJECTIVES

- / Mapping of key genetic defects in cancer cells. Genetic analyses of cancer cells in relation to the prediction of therapy response and resistance to modern anti-cancer drugs. Stratification of cancer patients for DNA-damaging and/or biological therapy. Detailed mapping of TP53 and ATM defects in cancer cells, including thorough functional, mutational, and cytogenetic analysis.
- / Drug testing on selected high-risk cancer cells.

## Molecular Oncology II – Solid Cancer



**Ondřej Slabý**  
Research Group Leader

### RESEARCH AREAS

- / Biology of the non-coding RNAs (microRNA, T-UCR, LncRNA, pyknons, etc.) and their involvement in carcinogenesis
- / Significance of non-coding RNAs in solid cancer pathogenesis and identification of new therapeutic targets
- / Application of non-coding RNAs in solid cancer diagnostics and individualization of therapy in cancer patients

### MAIN OBJECTIVES

/ Introduction of high-throughput analyses (whole genome sequencing and transcriptome profiling) of human genome mainly focused on non-coding RNAs. Comprehensive analysis of non-coding RNAs (expression, SNPs, methylation profiles,) in solid cancer (mainly colorectal cancer, renal cell carcinoma, esophageal cancer, breast cancer, lung cancer and glioblastoma multiforme). Detailed phenotypic characterization (e.g. validation of predicted targets of miRNAs and their integration into signalling pathways) and functional evaluation (proliferation, cell cycle, apoptosis, invasiveness, etc.) of non-coding RNAs suspected to be involved in carcinogenesis or cancer outcome in vitro in a relevant cell line models. Formulation and design of recommendations for potential implementation of novel biomarkers to clinical management of solid cancer patients leading to higher level of individualization and better therapeutic outcomes. Development and technological transfer of new targeted therapeutic strategies in solid cancer.

## Inherited Diseases I – Genetic Research



**Lenka Fajkusová**  
Research Group Leader

### RESEARCH AREAS

- / Molecular diagnostics of inherited neuromuscular, neurodegenerative, metabolic, and skin diseases (molecular diagnostics of 37 inherited diseases is performed at present)
- / Molecular modelling of mutations by methods of molecular dynamics
- / Introduction of high-throughput analyses into medical research and molecular diagnostics Transcriptional Regulation

### MAIN OBJECTIVES

/ Detection of mutation/mutations associated with a disease, analysis of correlation between patient's genotype and phenotype, molecular modelling and functional analysis of detected mutations.

/ Introduction of high-throughput analyses (sequence capture and targeted resequencing, whole genome sequencing, transcriptome profiling) of human genomes. Utilisation of these technologies in diagnostics and development of diagnostic tests.

## Inherited Diseases II – Transcriptional Regulation



**Dalibor Blažek**  
Research Group Leader

### RESEARCH AREAS

- / Regulation of eukaryotic transcription
- / Role of Cdk9, Cdk12 and Cdk13 in regulation of gene expression
- / Role of transcription cycle-related Cdks in maintenance of genome stability
- / Transcription cycle-related Cdks in human disease

### MAIN OBJECTIVES

- / Role of Cdks in phosphorylation of the C-terminal domain of RNA polymerase II and in the regulation of gene expression
- / Control of DNA damage response and genome stability via regulation of expression of DNA damage response genes

## Molecular Immunology and Microbiology



**Tomáš Freiberger**  
Research Group Leader

### RESEARCH AREAS

- / Characterisation of genetic factors of microbial pathogenicity, human susceptibility to infections and their interactions
- / Molecular diagnostics of primary immunodeficiencies
- / Functional analysis of mutations in genes involved in immune response
- / New diagnostic approaches in pathogen identification based on molecular methods

### MAIN OBJECTIVES

- / Genomic characterisation of medically important emerging pathogens; identification and characterisation of bacterial and fungal features on a genome-wide scale.
- / The analysis of genes involved in disturbed immune response predominantly in patients with immunodeficiencies. Mapping human mutations and polymorphisms associated with altered immune response and their functional analysis. Development of new diagnostic possibilities leading to improved early detection of etiological agents in patients with infectious complications using molecular methods.



## Genome Dynamics



**Eduard Kejnovský**  
Research Group Leader

### RESEARCH AREAS

- / Genome dynamics in model species and human
- / Microsatellite expansion and transposable element activity in relation to human diseases
- / Introduction of high-throughput analyses into medical research and diagnostics

### MAIN OBJECTIVES

- / Study of most dynamic components of genomes – microsatellites and transposable elements – in plants, animal and human.
- / Characterisation of dynamics of transposable elements and their relation to diseases.
- / Induction of transposable elements by stress conditions in model systems.
- / Identification of general mechanisms of microsatellite expansion in genomes.
- / Utilisation of cytogenetic and functional genomic methods and next generation sequencing approaches combined with bioinformatics.

## Core Facility – Genomics



**Boris Tichý**  
Research Group Leader

### RESEARCH AREAS

- / Operation of the Genomics Core Facility
- / New technologies in medical diagnostics
- / Improvement and new applications of molecular biology technologies

### MAIN OBJECTIVES

- / Introduction of high-throughput analyses (whole genome sequencing and transcriptome profiling) of human and microbial genomes.
- / Utilisation of these technologies in medicine and development of diagnostic tests based on the high-throughput methods.
- / Mutational analyses of human cells in relation to cancer, neuromuscular, neurodegenerative, metabolic and skin disorders; the detection of novel prognostic markers.

## Cellular and Molecular Neurobiology



**Petr Dubový**  
Research Group Leader

### RESEARCH AREAS

- / Cellular and molecular mechanisms responsible for both nerve regeneration and the induction of neuropathic pain
- / Research of immune mediators contributing to both nerve reparation and neuropathic pain
- / Neuroinflammatory propagation from nerve injury sites to other nervous system compartments by small molecules (cytokines, chemokines) and their receptors as a mechanism for neuropathic pain induction and general conditioning of nervous system to regeneration
- / Research in the endocannabinoid system in the nervous system of neuropathic pain models
- / New compounds to influence both functional reinnervation and neuropathic pain induction
- / New approaches targeted at critical inflammatory cells to attenuate neuropathic pain

### MAIN OBJECTIVES

- / Recognition of cellular and molecular mechanisms of selected nervous disorders.

## Molecular and Functional Neuroimaging



**Ivan Rektor**  
Research Group Leader

### RESEARCH AREAS

*The research group is primarily intended to uphold and support the operations of the Molecular and Functional Imaging Core Facility. In addition, the research group participates in these research areas:*

- / Development and improvement of imaging methods
- / Development and implementation of data analysis methods
- / Research in functional brain organization, plasticity and connectivity using imaging and electrophysiological methods
- / Development of new diagnostic methods

### MAIN OBJECTIVES

- / Development of new molecular and functional imaging methods and their translation into clinical neuroscience.
- / Use of the multimodal approach to the advanced study of cognitive and behavioural functions.

## Experimental and Applied Neuropsychopharmacology



**Alexandra Šulcová**  
Research Group Leader

### RESEARCH AREAS

#### Experimental pharmacology

- / Behavioural pharmacology research is focused on neurobiology and effects of drugs (including drugs of abuse: methamphetamine, ecstasy, cannabinoids) on motor functioning, emotionality, cognition
- / Pharmacokinetic research is focused on biotransformation mostly of psychotropic drugs by cytochrome P450 isoenzymes, their interactions and sex differences

#### Applied pharmacology

- / Analyses of safety and efficacy of pharmacotherapy with psychotropics related to patient's metabolic activity of CYP2D6 and CYP1A2

### MAIN OBJECTIVES

- / Recognition of cellular and molecular mechanisms of selected nervous disorders.
- / Development of new molecular and functional imaging methods and their translation into clinical neuroscience.
- / Usage of multimodal approach to the advanced study of cognitive and behavioural functions.

## Behavioural and Social Neuroscience



**Milan Brázdil**  
Research Group Leader

### RESEARCH AREAS

- / The study of functional connectivity in human brain during detection of rare events
- / The study of functional and anatomical connectivity of the brain in the context of integrative processes and the neurobiology of schizophrenia
- / Research of behavioural and neural mechanisms of decision-making processes in healthy subjects and neurodegenerative and movement disorders
- / Intracerebral electrophysiological correlates of cognitive and affective processing
- / Research of the cerebellum, basal ganglia and other subcortical structures and their cortical connections linked to the predictive motor timing and modulation of these connections
- / Research of neuronal synchrony in the visual cortex and implications for visual perception in space and time domains

### MAIN OBJECTIVES

- / The usage of multimodal approach to the advanced study of cognitive and behavioural functions.

## Applied Neuroscience



**Irena Rektorová**  
Research Group Leader

### RESEARCH AREAS

- / Biological markers of schizophrenia and neurodegenerative brain diseases such as Parkinson's disease and Alzheimer's disease: detection and harmonization of biological markers and their uses in early diagnosis, predictions of progression, prognoses and therapeutic outcomes (clinical, biochemical, neurocognitive, neuroimaging, and genetic markers)
- / Clinically oriented research focussed on individually tailored treatments of psychotic, and neurodegenerative disorders
- / The study of speech and its pathophysiological mechanisms in Parkinson's disease
- / The study of pathophysiological mechanisms of peripheral and central neuropathic pain
- / The study of immunopathogenesis and immunogenetics of autoimmune diseases
- / The study of immunopathogenesis and clinical manifestation of paraneoplastic neurological syndromes

### MAIN OBJECTIVES

- / Apply neuroscience research in the treatment of neurological and psychiatric diseases (e.g. neurodegenerative disease, neuropathic pain, autoimmune diseases, schizophrenia)
- / Research in specific pathophysiological mechanisms of brain disorders and their treatment options

# 7. Molecular Veterinary Medicine

## Molecular Virology



**Vladimír Celer**  
Research Group Leader

### RESEARCH AREAS

- / Porcine ssDNA viruses
- / Porcine arteriviruses
- / scFv antibodies
- / Protein expression

### MAIN OBJECTIVES

- / To obtain novel information on the causes, mechanisms and spreading of infectious diseases in domestic animals.



## Molecular Bacteriology



**Alois Čížek**  
Research Group Leader

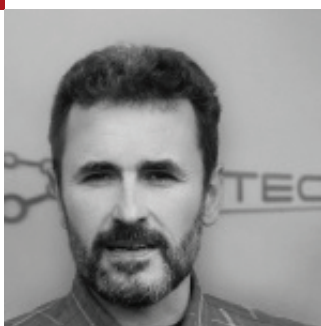
### RESEARCH AREAS

- / Antimicrobial-resistant bacteria in animal populations and environments
- / Comparative analysis of epidemiological plasmids carrying resistance genes
- / Molecular epidemiology of zoonotic bacteria and tick/vector-borne disease agents

### MAIN OBJECTIVES

- / To analyse the spread of antibiotic resistant bacteria from animals to humans
- / To identify genetic backgrounds of resistant bacteria, especially the association among plasmids and resistance genes
- / To study intestinal colonization with resistant bacteria in animals
- / To identify the ways to eliminate resistant bacteria
- / To study the biology of tick/vector-borne disease agents

## Parasitology



**Břetislav Koudela**  
Research Group Leader

### RESEARCH AREAS

- / Analysis of the aspects associated with diversity and host specificity of selected model groups of parasitic pathogens, their zoonotic potential and the risk of infectious diseases for human and domestic and wild animals emerging
- / Development of specific and sensitive molecular tools for the diagnosis of toxoplasmosis
- / Proteomic analysis of the excretory-secretory proteins of the *Trichinella* species and identification of key parasite proteins that are involved in the host-parasite interaction

### MAIN OBJECTIVES

- / To obtain novel information on the causes, mechanisms and spreading of infectious diseases in domestic animals.
- / Identification of mechanisms and prevention of the circulation of zoonotic pathogens and commensal antimicrobial-resistant bacteria in the food chain.

## Food Safety



**Iva Steinhauserová**  
Research Group Leader

### RESEARCH AREAS

- / Cultivation and identification of foodborne pathogens
- / Molecular biology characterisation of foodborne pathogens
- / Monitoring of zoonotic pathogens in food chain
- / Testing of resistance and survival of selected food-borne pathogens under different processing conditions

### MAIN OBJECTIVES

- / To obtain novel information on the causes, mechanisms and spreading of infectious diseases in domestic animals.
- / Identification of mechanisms and prevention of the circulation of zoonotic pathogens and commensal antimicrobial-resistant bacteria in the food chain.

## Orthopaedics and Surgery



**Alois Nečas**  
Research Group Leader

### RESEARCH AREAS

- / Small animal orthopaedics
- / Bone and joint surgery
- / Arthroscopy

### MAIN OBJECTIVES

- / To obtain novel information on mechanisms of infectious diseases in domestic animals.
- / Definition of the role of host genetics in infectious diseases.

## Animal Immunogenomics



**Petr Hořín**  
Research Group Leader

### RESEARCH AREAS

- / Immunogenetics and immunogenomics
- / Comparative and evolutionary genomics
- / Genetic resistance to infectious disease, host and pathogen interactions

### MAIN OBJECTIVES

- / To obtain novel information on genetic mechanisms of infectious diseases in domestic animals.
- / Definition of the role of host genetics in infectious diseases.
- / Analysis of genetic diversity, evolution and selection in selected immunity-related genes based on comparative immunogenomic analysis.
- / Analysis of genetic mechanisms of host and pathogen interactions.

## Animal Cytogenomics



**Jiří Rubeš**

Research Group Leader

### RESEARCH AREAS

/ Comparative molecular cytogenetics and genetics of reproduction

### MAIN OBJECTIVES

- / To obtain novel information on chromosomal rearrangements that have taken place during the process of evolution in the family Bovidae and Equidae by using comparative FISH.
- / Determination of associations between the frequencies of chromosomally abnormal sperm, semen parameters and the reproductive outcome of the carriers of chromosomal translocations.
- / Meiotic process including homologous synapsis, and frequency and distribution of recombination events will be studied on pachytene spermatocytes in animal models to elucidate the progress of meiosis in individuals with normal or abnormal karyotypes.

## Mammalian Reproduction



**Martin Anger**

Research Group Leader

### RESEARCH AREAS

- / Acquisition of meiotic competence in mammalian oocytes
- / Regulation of chromosome segregation in mammalian meiosis
- / Effect of maternal aging on chromosome segregation errors in oocytes
- / Fertilisation and transition from meiosis into mitosis
- / Regulation of chromosome segregation during early embryonic development

### MAIN OBJECTIVES

- / To identify the essential factors important for acquisition of meiotic competence in mammalian oocytes, especially those that are conserved between species.
- / To obtain detailed description of the crucial molecular mechanisms controlling chromosome segregation in mammalian oocytes.
- / To determine which of those mechanisms are primarily affected by maternal aging in mammalian oocytes.
- / To study the transition from meiosis into mitosis during fertilisation and accompanying changes of the cell cycle regulatory mechanisms.
- / To study the regulation of chromosome segregation during early embryonic development in mammals, especially the role of checkpoint mechanisms in this process.

## 3.3 Main Projects 2012

(Main research projects acquired or active in 2012)

### Advanced Nanotechnologies and Microtechnologies

#### Functional Properties of Nanostructures

- ▶ Electronic and structural properties of three-dimensional topological insulators (GAP204/12/0595), Czech Science Foundation, 2012 – 2014. O. Caha, Masaryk University, V. Holy, Charles University in Prague.
- ▶ SOI structures for advanced semiconductor applications (TA01010078), Technology Agency CR, 2011 – 2013, M. Lorenc, ON SEMICONDUCTOR CZECH REPUBLIC, J. Humlicek, Masaryk University.

#### Smart Nanodevices

- ▶ Nano-Electro-Bio-Tools for Biochemical and Molecularly-Biological Studies of Eukaryotic Cells (NanoBioTE-Cell) (GAP102/11/1068), Czech Science Foundation, 2011-2015, I. Provaznik, Brno University of Technology, R. Kizek, Mendel University in Brno.
- ▶ Study of contribution of different DNA-damaging mechanisms to toxicity of cytostatics to human chemosensitive and chemoresistant neuroblastomas (CYTORES) (GAP301/10/0356), Czech Science Foundation, 2010-2014, M. Stiborova, Charles University in Prague, R. Kizek, Mendel University in Brno.
- ▶ International Cooperation in the Field of Nanotechnologies with In Vivo Imaging Techniques (NANOLABSYS) (CZ.1.07/2.3.00/20.0148), EU, 2012-2014, R. Kizek, Brno University of Technology.
- ▶ Partner Network for Bionanotechnological and Metallomic Research (NANOBIOMETALNET) (CZ.1.07/2.4.00/31.0023), EU, 2012-2014, V. Adam, Brno University of Technology.
- ▶ New design and exploiting nanobiosensors and nanosensors to target medicine (NANOSEMED) (KAN208130801), Academy of Sciences of the Czech Republic, 2008-2012, J. Hubalek, Brno University of Technology, A. Horna, RADANAL, Ltd., R. Kizek, Mendel University in Brno.

#### Experimental Biophotonics

- ▶ Centre of digital optics (TE01020229), Technology Agency of the Czech Republic, 2012-2019, J. Rehacek, Palacky University Olomouc, P. Prikryl, Meopta-optika, Ltd., J. Oulehla, Pramacom-HT, Ltd., R. Chmelik, Brno University of Technology, L. Kapitan, Zebr, Ltd.
- ▶ Multimodal holographic microscope (FR-TI4/660), Ministry of Industry and Trade, 2012-2014, F. Lopour, TESCAN, R. Chmelik, Brno University of Technology, P. Hozak, Institute of Molecular Genetics AS CR.

#### Fabrication and Characterisation of Nanostructures

- ▶ Universal SEM as a multi-nano-analytical tool – UnivSEM, (FP7-NMP-2011-SME-5/280566), EU, 2012-2015, J. Jiruse, TESCAN.
- ▶ Advanced microscopy and spectroscopy platform for research and development in nano and microtechnologies – AMISPEC (TE01020233), Technology Agency CR, 2012-2019, T. Sikola, Brno University of Technology, P. Freundlich, ON SEMICONDUCTOR CR, F. Lopour, TESCAN, L. Kotacka, OPTAGLIO, J. Lazar, Institute of Scientific Instruments AS CR.
- ▶ Mapping of localized plasmon resonances at nanoantennas (GAP102/12/1881), Czech Science Foundation, 2012-2014, T. Sikola, Brno University of Technology.





- ▶ Fabrication of metallic nanostructures for spintronic applications (GPP102/12/P443), Czech Science Foundation, 2012-2014, M. Urbanek, Brno University of Technology.
- ▶ Fabrication of semiconductor nanowires with optimized functional properties (GPP108/12/P699), Czech Science Foundation, 2012-2014, M. Kolibal, Brno University of Technology.

## X-ray Micro CT and Nano CT

- ▶ Development of an interaction chamber for Laser-Induced Breakdown Spectroscopy (LIBS) (TA02011272), Technology Agency of the Czech Republic, 2012-2014, J. Kaiser, Brno University of Technology.
- ▶ Development of calibration-free quantitative laser-induced breakdown spectroscopy (LIBS) (ME10061), Ministry of Education, Youth and Sports, 2010-2012, J. Kaiser, Brno University of Technology.
- ▶ Utilization of the Laser Induced Plasma Spectroscopy (LIBS) for spectrochemical analysis of plant samples with high spatial resolution (ME09015), Ministry of Education, Youth and Sports, 2009-2012, J. Kaiser, Brno University of Technology.

## Optoelectronic Characterisation of Nanostructures

- ▶ Electron transport, noise and diagnostic of Schottky and autoemission cathodes (GAP102/11/0995), Czech Science Foundation, 2011-2014, L. Grmela, Brno University of Technology.
- ▶ Utilizations of electromagnetic and acoustic emission in research of advanced composite materials for structural applications (GAP104/11/0734), Czech Science Foundation, 2011-2014, P. Koktavý, Brno University of Technology.
- ▶ Diagnostics of material defects using the latest defectoscopic methods (GD102/09/H074), Czech Science Foundation, 2009-2013. K. Liedermann, Brno University of Technology, E. Belas, Charles University in Prague, K. Hajek, Ministry of Defence.
- ▶ Research and development progressive instruments for innovation surface quality of cast billets, bars and wires (FR-T12/536), Ministry of Industry and Trade, 2010-2012, R. Turon, Trinec Metalworks, D. Omacht, Material and Metallurgical Research, Ltd., L. Grmela, Brno University of Technology.
- ▶ Application of laser technologies into the process of crystalline silicon solar cells production (FR-T11/305), Ministry of Industry and Trade, 2009-2013, J. Hladík, Solartec, Ltd., V. Nedela, Institute of Scientific Instruments AS CR, V. Lang, University of West Bohemia, P. Koktavý, Brno University of Technology.

## Micro and Nanotribology

- ▶ Study of lubrication film forming properties of newtonian and non-newtonian lubricants and their rheology (ME09025), Ministry of Education, Youth and Sports, 2009-2012, M. Hartl, Brno University of Technology.
- ▶ Experimental study of the role of lubricant molecular degradation in film thickness formation (LH11002), Ministry of Education, Youth and Sports, 2011-2014, I. Krupka, Brno University of Technology.
- ▶ The behaviour of surface roughness in lubricated concentrated contacts (GAP101/11/1115), Czech Science Foundation, 2011-2015, I. Krupka, Brno University of Technology.

## Plasma Technologies

- ▶ Plasmachemical processes for synthesis of carbon nanotubes and the study of their functional properties (GAP205/10/1374), Czech Science Foundation, 2010-2014, L. Zajickova, Masaryk University, J. Hubalek, Brno University of Technology.
- ▶ Self-organization and structuralization in plasma enhanced chemical vapor deposition of thin films (7AMB12DE005), Ministry of Education of the Czech Republic, 2012-2013, L. Zajickova, Masaryk University.

## Synthesis and Analysis of Nanostructures

- ▶ Nonhydrolytic sol-gel reactions for the synthesis of silicates and phosphates with controlled porosity and surface functionality (LH11028), Ministry of Education, Youth and Sports, 2011-2014, J. Pinkas, Masaryk University.
- ▶ Novel front-end strategies for desorption mass spectrometry (GAP206/12/0538), Czech Science Foundation, 2012-2014, J. Preisler, Masaryk University.
- ▶ Thermodynamics of intermetallic phases using combined theoretical and experimental approach (GAP108/10/1908), Czech Science Foundation, 2010-2013, J. Pavlu, Masaryk University.
- ▶ Behaviour of geochemical „twins“ Al/Ga and Si/Ge in different types of acid silicate melts (GAP210/10/1309), Czech Science Foundation, 2010-2013, K. Breiter, Institute of Geology AS CR.
- ▶ Metal oxides and phosphates as nuclear waste forms: Sonochemical precipitation, thermal transformations, and solubility studies (GAP207/11/0555), Czech Science Foundation, 2011-2014, J. Pinkas, Masaryk University.

## Transport and Magnetic Properties

- ▶ Mesoscopic framework for modeling physical processes in multiphase materials with defects (MesoPhys-Def) (247705), EU, 2009-2013, R. Groger, Institute of Physics of Materials AS CR.
- ▶ Effects of cores and boundaries of nanograins on structural and physical properties of ball milled and mechanically alloyed iron-based materials (GAP108/11/1350), Czech Science Foundation, 2011-2014, Y. Jiraskova, Institute of Physics of Materials, AS CR, J. Cizek, Charles University in Prague, D. Jancik, Palacky University Olomouc.
- ▶ Talented postdocs for scientific excellence in physics of materials (CZ.1.07/2.3.00/30.0063), Ministry of Education, Youth and Sport, 2012-2015, L. Nahlik, Institute of Physics of Materials, AS CR.
- ▶ Human resources development in the research of physical and material properties of emerging, newly developed and applied engineering materials (CZ.1.07/2.3.00/20.0214), Ministry of Education, Youth and Sports, 2012-2015, L. Nahlik, Institute of Physics of Materials, AS CR.

## Advanced Materials

### Advanced Ceramic Materials

- ▶ Processing and properties of ferroics and multiferroics (LD11035), Ministry of Education, Youth and Sports, 2011-2013, K. Maca, Brno University of Technology.
- ▶ Support of the development of high-quality teams in R&D in the field of material science (EE2.3.20.0029), Ministry of Education, Youth and Sports, 2011-2014, E. Martincova, Brno University of Technology.
- ▶ Building up cooperation in R&D with the Research and Industrial Partners (Research4Industry) (CZ.1.07/2.4.00/17.0006), Ministry of Education, Youth and Sports, 2011-2014, R. Vrba, Brno University of Technology.
- ▶ Study of catalytically active nanoparticles and nanostructures for the synthesis of hydrogen (LD12004), Ministry of Education, Youth and Sports, 2012-2015, J. Cihlar, Brno University of Technology.

### Materials for Sensors and Technological Processes Control Systems

- ▶ ENIAC MotorBrain – Nanoelectronics for electric vehicle intelligent failsafe power train (270693), Infineon (Germany), 2011-2014, P. Vaclavek, Brno University of Technology.
- ▶ CAK3 – Center for applied cybernetics 3 (TE01010197), Technology Agency of the Czech Republic, 2012–2019, P. Vaclavek, Brno University of Technology.



- ▶ ARTEMIS IOE – Internet of energy for electric mobility (269374), 2011-2014, SINTEF (Norway), R. Vrba, Brno University of Technology.
- ▶ ARTEMIS POLLUX – Process oriented electrical control units for electrical vehicles developed on a multi-system real-time embedded platform (100205), SINTEF (Norway), 2010-2013, G. Kalivodova, Institute of Microelectronic Applications.

## Advanced Polymers and Composites

- ▶ Effect of nanoparticles on the chain mobility and crystallization kinetics in polyolefin nanocomposites (GAP205/10/2259), Czech Science Foundation, 2010-2013, J. Jancar, Brno University of Technology.

## Advanced Metallic Materials and Metal Based Composites

- ▶ Role of oxide dispersion in fatigue behaviour of ODS type steels (GA106/09/1954), Czech Science Foundation, 2009-2013, T. Kruml, Institute of Physics of Materials AS CR.
- ▶ Fracture behaviour prediction based on quantification of local material response (GAP108/10/0466), Czech Science Foundation, 2010-2013, I. Dlouhy, Brno University of Technology.
- ▶ Creep and oxidation properties of E110 claddings under LOCA temperature transient (TA02011025), Technology Agency of the Czech Republic, 2012-2015, V. Sklenicka, Institute of Physics of Materials AS CR, V. Vrtilkova, UJP Praha.
- ▶ Talented postdocs for scientific excellence in physics of materials (CZ.1.07/2.2.00/030.0063), 2012-2015, Ministry of Education, Youth and Sport, L. Nahlik, Institute of Physics of Materials AS CR.
- ▶ Human resources development in the research of physical and material properties of emerging newly developed and applied engineering materials (CZ.1.07/2.3.00/20.0214), 2012-2015, Ministry of Education, Youth and Sports, L. Nahlik, Institute of Physics of Materials AS CR.

## Structure and Phase Analysis

- ▶ Thermal spray processing and high temperature structural stability of nanocrystalline thermal barrier coatings (GAP107/12/1922), Czech Science Foundation, 2012-2014, J. Svejcar, Brno University of Technology, J. Dubsky, Institute of Plasma Physics AS CR.
- ▶ Protective diffusion coating on cast nickel-based superalloys for high temperature application (GAP107/11/2065), Czech Science Foundation, 2011-2014, K. Obrtlík, Institute of Physics of Materials AS CR.
- ▶ Processing of intermetallic layered structures and hypereutectic aluminium-based alloys using sacrificial nickel coatings (GPP107/12/P739), Czech Science Foundation, 2012-2014, L. Celko, Brno University of Technology.
- ▶ Research and development of roller bearing of mixer truck gearbox (FR-TI4/295), Ministry of Industry and Trade, 2012-2015, V. Zikmund, ZKL – Research and Development, V. Vansa, ZKL Brno, J. Svejcar, Brno University of Technology.
- ▶ Research and development of processing technology of non-toxic small caliber bullets (FR-TI4/194), Ministry of Industry and Trade, 2012-2015, V. Hlavacek, SVUM, P. Kratochvil, Sellier & Bellot, J. Svejcar, Brno University of Technology.



## Structural Biology

### Bioinformatics

- ▶ Internationalization of the Structural Biology Research Programme with Emphasis on New Directions in R&D (INBIOR) (CZ.1.07/2.3.00/20.0042), Ministry of Education, Youth and Sports, 2011-2014, V. Sklenar, Masaryk University.

### CD Spectroscopy of Nucleic Acids and Proteins

- ▶ DNA quadruplexes in human genome associated with disease and aging (GAP205/12/0466) Czech Science Foundation, 2012-2016, M. Vorlickova, Institute of Biophysics AS CR.
- ▶ Biophysics and bioinformatics of genomic DNA fragments very rich in guanine and adenine (IAA500040903), Academy of Sciences of the Czech Republic, 2009-2013, J. Kypr, Institute of Biophysics AS CR, V. Sklenar, Masaryk University.
- ▶ Formation and dynamics of nucleic acid motifs involved in regulation of gene expression (GA202/09/0193), Czech Science Foundation, 2009-2014, J. Stepanek, Charles University in Prague.

### Glycobiology

- ▶ Preparation of lectins with high specificity and affinity (GPP207/11/P185), Czech Science Foundation, 2011-2013, M. Pokorna, Masaryk University.
- ▶ Identification, caractérisation et détermination du rôle des lectines impliquées dans l'adhésion des champignons filamenteux *Aspergillus fumigatus* et *Scedosporium apiospermum* (RF20110600501) Vaincre la Mucoviscidose, France 2011-2013, A. Varrot, CERMAV, M. Wimmerova, Masaryk University.
- ▶ The ways to N-acetyl-mannosamine structures via mannoside metabolizing enzymes (GAP207/10/0321), Czech Science Foundation, 2010-2013, L. Weignerova, Institute of Microbiology AS CR, M. Wimmerová, Masaryk University.
- ▶ Lectins from human pathogens – structure, function, engineering (GA303/09/1168), Czech Science Foundation, 2009-2012, M. Wimmerova, Masaryk University.
- ▶ Design of Carbohydrates and Glycomimetics as Antibacterial and Antiviral Drugs (ME08008), Ministry of Education, Youth and Sports, 2008-2012, M. Wimmerova, Masaryk University.
- ▶ Structure-functional characterisation of oxidoreductases acting on nitrogenous regulatory compounds in plants (GA522/08/0555), Czech Science Foundation, 2008-2012, M. Sebelá, Palacky University Olomouc, M. Wimmerova, Masaryk University.

### RNA Quality Control

- ▶ Functional and biochemical characterization of DIS3L2, the third mammalian homolog of the key yeast exosome nuclease Dis3p (GAP305/11/1095), Czech Science Foundation, 2011-2014, S. Vanacova, Masaryk University.
- ▶ Polyadenylation and mechanisms of nuclear RNA quality control (084316/Z/07/Z), Wellcome Trust, 2008-2013, S. Vanacova, Masaryk University.
- ▶ Centre of excellence – Centre for RNA biology (GAP305/12/G034), 2012-2018, Czech Science Foundation, L. Valasek, Institute of Microbiology AS CR, R. Stefl, Masaryk University.





## Nanobiotechnology

- ▶ BIOMIMIC – Biomimetic sensors as a new generation of biotechnological devices for food safety and quality monitoring (230849), Università degli Studi di Teramo (Italy), 2009-2012, P. Skladal, Masaryk University.
- ▶ Interactions of mutant forms of cryptogein with a membrane binding site: biosensors-based characterization (GAP501/11/1003), Czech Science Foundation, 2011-2015, P. Skladal, Masaryk University.
- ▶ Nanobiotechnologies and biosensor for biointeraction studies – opening up the modern technology to researchers in biology (CZ.1.07/2.3.00/09.0167), Ministry of Education, Youth and Sports, 2009-2012, P. Skladal, Masaryk University.

## Biomolecular NMR Spectroscopy

- ▶ Allosteric effects induced in 14-3-3 targets (235902), EU, 2010-2013, V. Sklenar, Masaryk University.
- ▶ Environmentally Controlled Polymorphism of non-B DNA structures (322104), EU, 2012-2016, V. Papouskova, Masaryk University.
- ▶ Development of high-resolution methodology for NMR studies of disordered proteins with highly degenerated resonance frequencies (GAP206/11/0758), Czech Science Foundation, 2011-2013, L. Zidek, Masaryk University.
- ▶ East-NMR (228461), EU, 2009-2013, M. Schmitt, Goethe University Frankfurt am Main, V. Sklenar, Masaryk University.
- ▶ Bio-NMR Facilities (261863), EU, 2010-2014, I. Bertini, CIRMMP, V. Sklenar, Masaryk University.

## RNA-based Regulation of Gene Expression

- ▶ Internationalization of the Structural Biology Research Programme with Emphasis on New Directions in R&D (INBIOR) (CZ.1.07/2.3.00/20.0042), Ministry of Education, Youth and Sports, 2011-2014, V. Sklenar, Masaryk University.

## Structural Biology of Gene Regulation

- ▶ Structural basis for poly(A) independent transcription termination pathway (GAP305/10/1490), Czech Science Foundation, 2010-2014, R. Stefl, Masaryk University.
- ▶ Centre of excellence – Centre for RNA biology (GAP305/12/G034), 2012-2018, Czech Science Foundation, L. Valasek, Institute of Microbiology AS CR, R. Stefl, Masaryk University.

## Structure and Dynamics of Nucleic Acids

- ▶ Structural dynamics, molecular interactions and function of key RNA motifs (GA203/09/1476), Czech Science Foundation, 2009-2013, J. Sponer, Institute of Biophysics AS CR.
- ▶ Structure and dynamics of DNA. Advanced computational studies (GAP208/12/1822), Czech Science Foundation, 2011-2016, J. Sponer, Institute of Biophysics AS CR.
- ▶ RNA Center (P305/12/G03), Czech Science Foundation, 2012-2019, L. Valasek, Institute of Microbiology AS CR.
- ▶ Theoretical and experimental studies related to the prebiotic chemistry of nucleic acids (GAP208/10/2302), Czech Science Foundation, 2010-2014, J. E. Sponer, Institute of Biophysics AS CR.



## Structure and Interaction of Biomolecules at Surfaces

- ▶ DNA labelling with redox markers for electrochemical sensing. Applications in analysis of nucleotide sequences and molecular diagnostics (IAA400040901), Academy of Sciences of the Czech Republic, 2009-2013, M. Fojta, Institute of Biophysics AS CR, M. Hocek, Institute of Organic Chemistry and Biochemistry AS CR.
- ▶ Construction of novel functional nucleic acids for applications in chemical biology, catalysis and self assembly (GA203/09/0317), Czech Science Foundation, 2009-2013, M. Hocek, Institute of Organic Chemistry and Biochemistry AS CR, M. Fojta, Institute of Biophysics AS CR.
- ▶ Novel electrochemical sensors and sensing techniques for the analysis of nucleic acids structure and interactions (GAP206/11/1638), Czech Science Foundation, 2011-2015, M. Fojta, Institute of Biophysics AS CR, B. Yosypchuk, J. Heyrovsky Institute of Physical Chemistry AS CR.

## Computational Chemistry

- ▶ SYLICA - Synergies of life and material sciences to create a new future (286154), FP7-CAPACITIES, EU, 2011-2014, J. Koca, Masaryk University.
- ▶ Research of acetylcholinesterase reactivation by methods of computation chemistry (OVMSUN200901), Ministry of Defence, 2009-2012, J. Koca, Masaryk University.
- ▶ Molecular and structural biology of selected antitumor drugs. From mechanistic studies to chemotherapy of tumors (GD301/09/H004), Czech Science Foundation, 2009-2013, V. Brabec, Institute of Biophysics AS CR.
- ▶ InterBioNet – Support of the international and intersectoral R&D co-operation in the field of life sciences (CZ.1.07/2.4.00/17.0042), Ministry of Education, Youth and Sports, 2011-2014, J. Koca, Masaryk University.

## Genomics and Proteomics of Plant Systems

### Bioanalytical Instrumentation

- ▶ Center for advanced bioanalytical technologies (GBP206/12/G014), Czech Science Foundation, 2012-2018, F. Foret, Institute of Analytical Chemistry AS CR, Z. Glatz, CEITEC-Masaryk University, Z. Hurak, FEE-Czech Technical University.
- ▶ New methods of analysis of proteins and their glycosylation in cancer – combination of electrochemistry, microfluidic biosensors and mass spectrometry (GAP301/11/2055), Czech Science Foundation, 2011-2015, F. Foret, Institute of Analytical Chemistry AS CR.
- ▶ Development of Multidisciplinary Research and Educational Centrum for Bioanalytical Technologies (CZ.1.07/2.3.00/20.0182), Ministry of Education, Youth and Sports, 2012-2014, Z. Glatz, CEITEC-Masaryk University, F. Foret, Institute of Analytical Chemistry AS CR.
- ▶ OnkoDetect – system for early detection of cancer markers in peripheral blood of patients (TA02010672), Technology Agency of the Czech Republic, 2012-2016, M. Minarik, Genomac International, F. Foret, Institute of Analytical Chemistry AS CR.



## Plant Cytogenomics

- ▶ Evolution and function of complex plant genomes (P501/12/G090), Czech Science Foundation, 2012-2018, B. Vyskot, Institute of Biophysics AS CR, M. A. Lysak, Masaryk University, J. Dolezel, Institute of Experimental Botany AV CR, J. Macas, Biology Centre AS CR.
- ▶ Evolutionary patterns in polyploid complexes: congruent or discordant histories in three examples from the Brassicaceae family (GAP506/12/0668), Czech Science Foundation, 2012-2015, M. A. Lysak, Masaryk University, K. Marhold, Charles University Prague.
- ▶ EVOGEN – Development of excellence in evolutionary cytogenomics, epigenetics and cell Signalling (CZ.1.07/2.3.00/20.0189), Ministry of Education, Youth and Science, 2012-2015, M. A. Lysak, Masaryk University.

## Functional Genomics and Proteomics of Plants

- ▶ The role of cytokinins and auxin interactions in the regulation of root gravitropism in *Arabidopsis thaliana* (GAP501/11/1150), Czech Science Foundation, 2011-2013, J. Hejatko, Masaryk University.
- ▶ Immunomodulation as a functional proteomics tool for cytokinin signaling study in *Arabidopsis thaliana* (GA521/09/1699), Czech Science Foundation, 2009-2012, L. Janda, Masaryk University, M. Faldyna, Veterinary Research Institute.
- ▶ Structural basis for the specificity of signal transduction in plants: interaction network of histidine kinase receiver domains in *Arabidopsis* (GAP305/11/0756), Czech Science Foundation, 2011-2014, L. Zidek, Masaryk University.

## Metabolomics

- ▶ Miniaturized on-line drug-metabolism system based on capillary electrophoresis (GAP206/10/0057), Czech Science Foundation, 2010-2013, Z. Glatz, Masaryk University.
- ▶ Capillary electrophoresis as a member of the metabolomic analytical toolbox (GAP206/11/0009), Czech Science Foundation, 2011-2015, Z. Glatz, Masaryk University.

## Proteomics

- ▶ Functional characterization of pollen unique storage ribonucleoprotein particles (GAP501/11/1462), Czech Science Foundation, 2011-2015, D. Honys, Institute of Experimental Botany AS CR, Z. Zdrahal, Masaryk University.
- ▶ Center of novel approaches to bioanalysis and molecular diagnostics (P206/12/G151), Czech Science Foundation, 2012-2018, M. Fojta, Institute of Biophysics AS CR, M. Hocek, Institute of Organic Chemistry and Biochemistry AS CR, B. Vojtesek, Masaryk Memorial Cancer Institute, Z. Zdrahal, Masaryk University, J. Berek, Charles University.
- ▶ Methods of eradication of production diseases of cattle – bovine viral diarrhoea – mucosal disease and paratuberculosis (QI101A094), Ministry of Agriculture, 2010-2014, M. Faldyna, Institute of Veterinary Research, Z. Zdrahal, Masaryk University, V. Celer, University of Veterinary and Pharmaceutical Sciences Brno, J. Kucera, Farmers Union of Czech Pied Cattle.

## Chromatin Molecular Complexes

- ▶ Dynamics of shelterin complex assembly (P205/12/0550), Czech Science Foundation, 2012-2015, C. Hofr, Masaryk University.
- ▶ Telomeres and telomerase: transition from molecular to structural biology approach (IAA500040801), Academy of Sciences of the Czech Republic, 2008-2012, E. Sykorova, Institute of Biophysics AS CR, J. Fajkus, Masaryk University.



- ▶ Epigenetic mechanisms of plant telomeres regulation (GAP501/11/0569), Czech Science Foundation, 2011-2015, M. Fojtova, Masaryk University.
- ▶ Loss of specific DNA repeats in response to dysfunction of CAF1 in plants (GAP501/11/0289), Czech Science Foundation, 2011-2016, J. Fajkus, Masaryk University.

## Developmental and Production Biology – Omics Approaches

- ▶ The role of cytokinins and polyamines in heat stress response and thermotolerance in tobacco and Arabidopsis plants (GA206/09/2062), Czech Science Foundation, 2009-2013, R. Vanková, Institute of Experimental Botany AS CR, B. Brzobohatý, Mendel University in Brno.
- ▶ Application of conventional and molecular genetic approaches for the development of grain legumes resistant to viral and fungal pathogens and insect pests (QI91A229), National Agency for Agriculture Research, 2009-2013, M. Griga, Agritec Plant Research Ltd., D. Kodrík, Biology Centre AS CR, M. Navrátil, Palacký University Olomouc, V. Reinöhl, Mendel University in Brno.

## Plant Stress Signalling and Adaptation

- ▶ ROS and auxin crosstalk during plant development and stress adaptation (333844), FP7-PEOPLE, Marie-Curie Action: Career Integration Grants, 2013-2017, V. Tognetti, Masaryk University.

## Molecular Medicine

### Medical Genomics

- ▶ Functional and structural changes of microRNAs in lymphoproliferative malignancies and their impact on prognosis and prediction of therapy response (NT11218), Ministry of Health, 2010-2015, Šárka Pospíšilová, Masaryk University.
- ▶ Functional and molecular characteristics of cancer and normal stem cells – identification of targets for novel therapeutics and therapeutic strategies (MSM0021622430), Ministry of Education, Youth and Sports, 2007-2013, Petr Dvorák, Masaryk University.
- ▶ Real-time PCR kits for detection in oncology (FR-TI2/254), Ministry of Industry and Trade, 2010-2013, Martin Buncek, GENERI BIOTECH, Ltd., Šárka Pospíšilová, Masaryk University.
- ▶ Support of professional growth and international integration of research in the field of molecular medicine CZ.1.07/2.3.00/20.0045), Ministry of Education, Youth and Sports, 2011-2014, Šárka Pospíšilová, Masaryk University.
- ▶ Involvement of nuclear HMGB proteins in sensitizing of human cells to anticancer drugs inhibiting DNA topoisomerases (GAP301/10/0590), GACR, 2010-2012, Michal Štros, Institute of Biophysics AS CR, Šárka Pospíšilová, University Hospital Brno.

### Molecular Oncology II – Solid Cancer

- ▶ Identification and functional characterization of microRNAs with predictive significance in patients with glioblastoma; O. Slaby; 2010-2013; NT/11214 Ministry of Health of the Czech Republic Departmental Programme of Research&Development.
- ▶ Development of diagnostic panel of circulating microRNAs for non-invasive early diagnostics and follow-up of colorectal cancer patients; O. Slaby; 2012-2015; NT/13549 Ministry of Health of the Czech Republic Departmental Programme of Research&Development.





- ▶ Study of epithelial-to-mesenchymal transition associated microRNAs and genes as potential markers for prediction of risk and early detection of metastatic disease in renal cell carcinoma patients; M. Redova; 2012-2015; NT/13547 Ministry of Health of the Czech Republic Departmental Programme of Research&Development.
- ▶ MicroRNA analysis in glioblastoma stem cells: prediction of therapy response and identification of new therapeutic targets in glioblastoma patients; ; J. Sana; 2012-2015; NT/13514 Ministry of Health of the Czech Republic Departmental Programme of Research&Development.
- ▶ Analysis of EGFR signalling and microRNA expression profiles in prediction of response to anti-EGFR therapy in colorectal cancer patients with wild-type KRAS; R. Vyzula; 2012-2015; NT/13860 Ministry of Health of the Czech Republic Departmental Programme of Research&Development.
- ▶ Complex characterization of molecular genetic changes in glioblastoma multiforme and its relapses, and evaluation of their possible significance in oncologic therapy and therapy effect; M. Hajduch; 2012-2015; NT/13581 Ministry of Health of the Czech Republic Departmental Programme of Research&Development.
- ▶ Development of microRNA diagnostic panel for identification Barrett esophagus patients at high-risk of progression to adenocarcinoma; J. Ehrmann; 2012-2014; NT/13585 Ministry of Health of the Czech Republic Departmental Programme of Research&Development.

## Inherited Diseases II – Transcriptional Regulation

- ▶ The novel isoform of cyclin K is a partner of cdk12 kinase regulating eukaryotic transcription and alternative splicing (GAP305/11/1564), Czech Science Foundation, 2011-2013, Dalibor Blažek, Masaryk University.
- ▶ Novel methylation of Hexim1 and cyclin composition of positive transcription elongation factor b (P-TEFb) regulate kinase activity of cdk9 (ME09047), Ministry of Education, Youth and Sports, 2009-2013, Dalibor Blažek, University Hospital Brno.
- ▶ Regulation and function of P-TEFb complexes (SRGA 454), 35 months, SoMoPro Reintegration Grant, Dalibor Blažek, Masaryk University.

## Genome Dynamics

- ▶ Sex chromosomes and dynamics of transposable elements (GAP305/10/0930), Czech Science Foundation, 2010-2014, Eduard Kejnovský, Institute of Biophysics AS CR.

## Brain and Mind Research

### Cellular and Molecular Neurobiology

- ▶ Brains (CZ.1.07/2.3.00/20.0041), Ministry of Education, Youth and Sports, 2011-2014, M. Brazdil, Masaryk University
- ▶ InterBioNet - Support of the international and intersectoral R&D co-operation in the field of life sciences (CZ.1.07/2.4.00/17.0042), Ministry of Education, Youth and Sports, 2011-2014, J. Koca, Masaryk University
- ▶ SYLICA – Synergies of Life and Material Sciences to Create a New Future (286154), FP7-CAPACITIES, EU, 2011-2014, J. Koca, Masaryk University



## Molecular and Functional Neuroimaging

- ▶ Comparison and inference of methods for evaluation of functional and effective connectivity in fMRI (GAP103/12/0552), Czech Science Foundation, 2012-2015, M. Mikl, Masaryk University
- ▶ The optimisation of methodics of analysis and evaluation of the simultaneous EEG-fMRI in patient with pharmaco-resistant epilepsy (GAP304/11/1318), Czech Science Foundation, 2011-2014, M. Brazdil, Masaryk University.
- ▶ Speech, its impairment and cognitive performance in Parkinson's disease (NT13499), Ministry of Health, 2012-2015, I. Rektorova, Masaryk University.
- ▶ Cerebellum, cognitive dysfunction, and motor control and time estimation mechanisms in dystonia and schizophrenia (NT13437), Ministry of Health, 2012-2015, M. Bares, Masaryk University.

## Behavioural and Social Neuroscience

- ▶ The Optimization of methodics of analysis and evaluation of the simultaneous EEG-fMRI in patient with pharmaco-resistant epilepsy (GAP304/11/1318), Czech Science Foundation, 2011-2013, M. Brazdil, Masaryk University, R. Kuba, University Hospital Brno, J. Jan, Brno University of Technology.

## Applied Neuroscience

- ▶ Biomarkers for Alzheimer's disease and Parkinson's disease: BIOMARKAPD (29410), EU Joint Programme – Neurodegenerative Disease Research, 2012-2015, B. Winblad, Karolinska Institutet Alzheimer Disease Research Center, I. Rektorova, Masaryk University.
- ▶ Spondylotic cervical cord compression, its prevalence, diagnosis and prognosis (NT13449), Ministry of Health, 2012-2015, J. Bednarik, University Hospital Brno.
- ▶ Specific characteristics of neuropathic pain of central and peripheral type (NT13523), Ministry of Health, 2012-2015, E. Vlckova, University Hospital Brno.
- ▶ Speech, its impairment and cognitive performance in Parkinson's disease (NT13499), Ministry of Health, 2012-2015, I. Rektorova, Masaryk University.
- ▶ Cerebellum, cognitive dysfunctions, and motor control and time estimation mechanism in dystonia and schizophrenia (NT13437), Ministry of Health, 2012-2015, M. Bares, Masaryk University.

## Molecular Veterinary Medicine

### Molecular Virology

- ▶ Porcine anelloviruses – prevalence, genotypization and pathogenesis (ME08108), Ministry of Education, Youth and Sports, 2008-2012, V. Celer, University of Veterinary and Pharmaceutical Sciences Brno.
- ▶ The role of small ORFs in the pathogenesis of porcine circovirus 2 diseases (GA524/09/0673), Czech Science Foundation, 2009-2012, V. Celer, University of Veterinary and Pharmaceutical Sciences Brno.
- ▶ Development of preparation with content of anti-sense oligonucleotides in nanoparticles for the local treatment of herpes virus infections caused by viruses HSV – 1 and HSV – 2 (FR-TI1/200), Ministry of Industry and Trade, 2009-2013, M. Krajíček, FAVEA, Ltd., R. Horváth, Genex CZ, Ltd., V. Celer, University of Veterinary and Pharmaceutical Sciences Brno.



## Molecular Bacteriology

- ▶ Characterisation of coliform bacteria resistant to cephalosporins and the risk assessment of antimicrobials usage for their selection (GPP502/10/P083), Czech Science Foundation, 2010-2013, M. Dolejska, University of Veterinary and Pharmaceutical Sciences Brno.
- ▶ Population structure and evolutionary relationships of the intracellular parasite *Hemolivia mauritanica* (Sergent and Sergent, 1904) (GAP506/11/1738), Czech Science Foundation, 2011-2015, V. Hypsa, Biology Centre of the Academy of Sciences of the Czech Republic

## Parasitology

- ▶ Development of the new tools for surveillance of trichinellosis in domestic swine and wildlife animals in the Czech Republic (QH81069), Ministry of Agriculture, 2008-2012, B. Koudela, University of Veterinary and Pharmaceutical Sciences Brno, K. Kovařík, Veterinary Research Institute.
- ▶ Immunogenetic study of a house mouse hybrid zone (GA206/08/0640), Czech Science Foundation, 2008-2012, J. Piálek, Institute of Vertebrate Biology AS CR, P. Síma, Institute of Microbiology AS CR, M. Macholán, Institute of Animal Physiology and Genetics AS CR, V. Holáň, Institute of Molecular Genetics AS CR, P. Munclinger, Charles University in Prague, D. Modrý, University of Veterinary and Pharmaceutical Sciences Brno.

## Animal Immunogenomics

- ▶ Comparative immunogenomics of the family Equidae (GA523/09/1972), Czech Science Foundation, 2009-2012, P. Hořin, University of Veterinary and Pharmaceutical Sciences Brno, P. Musilová, Veterinary Research Institute, J. Lukeš, Biology Centre AS CR.

## Animal Cytogenomics

- ▶ Phylogenetic relationships in the family Bovidae studied by analysis of subfamily specific DNA repeats and karyotype (GAP506/10/0421), Czech Science Foundation, 2010-2013, J. Rubeš, Veterinary Research Institute.
- ▶ Comparative study of male meiosis in members of the family Bovidae (GAP502/11/0719), Czech Science Foundation, 2011-2015, M. Vozdová, Veterinary Research Institute.

## Mammalian Reproduction

- ▶ EMBO Installation Grant, 2009-2013, M. Anger, Institute of Animal Physiology and Genetics, AS CR.
- ▶ The changes in important regulatory mechanisms of meiotically dividing mammalian oocytes induced by ageing (GA523/09/0743), Czech Science Foundation, 2009-2013, M. Anger, Institute of Animal Physiology and Genetics AS CR.
- ▶ Transition from meiosis into mitosis: changes of the mechanisms controlling cell division (P502/12/2201), Czech Science Foundation, 2012-2016, M. Anger, Veterinary Research Institute, M. Kubelka, Institute of Animal Physiology and Genetics AS CR.
- ▶ CeDiLa - Strategic development of the cell division laboratory (CZ.1.07/2.3.00/20.0213), Ministry of Education, Youth and Sports, 2012-2015, Veterinary Research Institute.

## 3.4 Selected Publications

### Advanced Nanotechnologies and Microtechnologies

#### Functional Properties of Nanostructures

- ▶ VASATKO, J., MUNZAR, D. Quantum mechanical picture of the coupling between interlayer electronic excitations and infrared active phonons in bilayer cuprate superconductors. *Physical Review B*. 2012, 86 (1), 5 p.
- ▶ KLENOVSKY, P., BREHM, M., KRAPEK, V., LAUSECKER, E., MUNZAR, D., HACKL, F., STEINER, H., FROMHERZ, T., BAUER, G., HUMLICEK, J. Excitation intensity dependence of photoluminescence spectra of SiGe quantum dots grown on prepatterned Si substrates: Evidence for biexcitonic transition. *Physical Review B*. 2012, 86(11), 8 p.
- ▶ OBERTA, P., HRDY, J., MIKULIK, P. A proof-of-principle experiment of a novel harmonics separation optics for synchrotron facilities. *Journal of Synchrotron Radiation*. 2012, 19(6), p. 1012-1014.
- ▶ MEDUNA, M., RUZICKA, J., CAHA, O., BURSIK, J., SVOBODA, M. Precipitation in silicon wafers after high temperature preanneal studied by X-ray diffraction methods. *Physica B*. 2012, 407(15), p. 3002-3005.
- ▶ JUNG, Y. W., BYUN J.S., KIM, Y.D., HEMZAL, D., HUMLICEK, J. Study of the interaction between HSA and oligo-DNA using total internal reflection ellipsometry. *Journal of the Korean Physical Society*, 2012, 60(8), p. 1288-1291.

#### Smart Nanodevices

- ▶ DOSPIVOVA, D., HYNEK, D., KOPEL, P., BEZDĚKOVÁ, A., SOCHOR, J., KŘÍŽKOVÁ, S., ADAM, V., TRNKOVÁ, L., HUBÁLEK, J., BABULA, P., PROVAZNÍK, I., VRBA, R., KIZEK, R. Electrochemical behaviour of apoferritin encapsulating of silver(I) ions and its application for treatment of *Staphylococcus aureus*. *International Journal of Electrochemical Science*. 2012, 7, p. 6378-6395.
- ▶ KIZEK, R., ADAM, V., HRABETA, J., ECKSCHLAGER, T., SMUTNY, S., BURDA, J. V., FREI, E., STIBOROVA, M. Anthracyclines and ellipticines as DNA-damaging anticancer drugs: Recent advances. *Pharmacology and Therapeutics*, 2012, 133(1), p. 26-39.
- ▶ ZITKA, O., RYVOLOVA, M., HUBALEK, J., ECKSCHLAGER, T., ADAM, V., KIZEK, R. From amino acids to proteins as targets for metal-based drugs. *Current Drug Metabolism*, 2012, 13(3), p. 306-320.
- ▶ ZITKA, O., MERLOS, M., ADAM, V., FERROL, N., POHANKA, M., HUBALEK, J., ZEHNAL, J., TRNKOVA, L., KIZEK, R. Electrochemistry of copper(II) induced complexes in mycorrhizal maize plant tissues. *Journal of Hazardous Materials*. 2012, 203-204, p. 257-263.

#### Experimental Biophotonics

- ▶ BOUCHAL, P., BOUCHAL, Z. Selective edge enhancement in three-dimensional vortex imaging with incoherent light. *Optics Letters*. 2012, 37(14), p. 2949-2951.

#### Fabrication and Characterisation of Nanostructures

- ▶ KOLIBAL, M., KONECNY, M., LIGMAJER, F., SKODA, D., VYSTAVEL, T., ZLAMAL, J., VARGA, P., SIKOLA, T. Guided Assembly of Gold Colloidal Nanoparticles on Silicon Substrates Prepatterned by Charged Particle Beams. *ACS Nano*. 2012, 6 (11), p. 10098-10106.
- ▶ KALOUSEK, R., DUB, P., BRINEK, L., SIKOLA, T. Response of Plasmonic Resonant Nanorod: An Analytical Approach. *Optics Express*. 2012, 20(16), p. 17916-17927.





- ▶ KOLIBAL, M., KALOUSEK, R., VYSTAVEL, T., NOVAK, L., SIKOLA, T. Controlled faceting in <110> germanium nanowire growth by switching between vapor-liquid-solid and vapor-solid-solid growth. *Applied Physics Letters*. 2012, 100(20), 4 p., 203102.
- ▶ KLEY, S.CH., ČECHAL, J., KUMAGAI, T., SCHRAMM, F., RUBEN, M., STEPANOW, S., KERN, K. Highly Adaptable Two-Dimensional Metal-Organic Coordination Networks on Metal Surfaces. *Journal of the American Chemical Society*. 2012, 134, p. 6072-6075.

## X-ray Micro CT and Nano CT

- ▶ KAISER, J., NOVOTNY, K., MARTIN, M., Z., HRDLICKA, A., MALINA, R., HARTL, M., ADAM, V., KIZEK, R. Trace elemental analysis by laser-induced breakdown spectroscopy – Biological applications. *Surface Science Reports*. 2012, 67(11, 12), p. 233–243.
- ▶ KAISER, J., STEPANKOVA, K., KORISTKOVA, T., SEDO, O., MELNYK, G., HARTL, M., PALOUSEK, D., KUCERA, J. Determination of the cause of selected canine urolith formation by advanced analytical methods. *Journal of Small Animal Practice*, 2012, 53(11), p. 646-651.
- ▶ POŘÍZKA, P., PROCHAZKA, D., PILÁT, Z., KRAJCAROVÁ, L., KAISER, J., MALINA, R., NOVOTNÝ, J., ZEMÁNEK, P., JEŽEK, J., ŠERÝ M., BERNATOVÁ, S., KRZYŽÁNEK, V., DOBRANSKÁ, K., NOVOTNÝ, K., TRTÍLEK, M., SAMEK, O. Application of laser-induced breakdown spectroscopy to the analysis of algal biomass for industrial biotechnology. *Spectrochimica Acta Part B*. 2012, 74-75, p. 169-176.
- ▶ VITKOVA, G., NOVOTNY, K., PROKES, L., HRDLICKA, A., KAISER, J., NOVOTNY, J., MALINA, R., PROCHAZKA, D. Fast identification of biominerals by means of stand-off laser-induced breakdown spectroscopy using linear discriminant analysis and artificial neural networks. *Spectrochimica Acta Part B: Atomic Spectroscopy*. 2012, 73, p. 1–6.

## Optoelectronic Characterisation of Nanostructures

- ▶ GRMELA, L., SKARVADA, P., TOMANEK, P., MACKU, R., SMITH, S. Local investigation of thermal dependence of light emission from reverse-biased monocrystalline silicon solar cells. *Solar Energy Materials and Solar Cells*. 2012, 96(1), p. 108-111.
- ▶ SEDLAK, P., SIKULA, J., MAJZNER, J., VRNATA, M., FITL, P., KOPECKY, D., VYSLOUZIL, F., HANDEL, P. Adsorption–desorption noise in QCM gas sensors. *Sensors and Actuators, B: Chemical*. 2012, 166, p. 264–268.

## Micro and Nanotribology

- ▶ SPERKA, P.; KRUPKA, I.; HARTL, M. Experimental study of real roughness attenuation in rolling-sliding concentrated contacts. *Tribology International*. 2012, 46(1), p. 14-21.

## Plasma Technologies

- ▶ NECAS, D., Klapetek, P. One-dimensional autocorrelation and power spectrum density functions of irregular regions. *Ultramicroscopy*. 2013, 124, p. 13-19.

## Synthesis and Analysis of Nanostructures

- ▶ KANA, T., SOB, M. Mechanical and magnetic properties of Mn-Pt compounds and nanocomposites. *Physical Review B*. 2012, 85(21), 9 p.
- ▶ SOBOTNIK, J., BOURGUIGNON, T., HANUS, R., DEMIANOVA, Z., PYTELKOVA, J., MARES, M., FOLTYNOVA, P., PREISLER, J., CVACKA, J., KRASULOVA, J., ROISIN, Y. Explosive backpacks in old termite workers. *Science*. 2012, 337(6093), p. 436.
- ▶ STYSKALIK, A., SKODA, D., PINKAS, J., MATHUR, S. Non-hydrolytic synthesis of titanosilicate xerogels by acetamide elimination and their use as epoxidation catalysts. *The Journal of Sol-Gel Science and Technology*. 2012, 63(3), p. 463-472.



- ▶ HSIEH, Y., CHEN, W., TOMALOVA, I., PREISLER, J., CHANG, H. Detection of melamine in infant formula and grain powder by surface-assisted laser desorption/ionization mass spectrometry. *Rapic Communications in Mass Spectrometry*. 2012, 26(12), p. 1393-1398.
- ▶ FOLTYNOVA, P., KANICKY, V., PREISLER, J. Diode laser thermal vaporization inductively coupled plasma mass spectrometry. *Analytical Chemistry*. 2012, 84(5), p. 2268–2274.

## Transport and Magnetic Properties

- ▶ DAVID, B., SCHNEEWEIS, O., SANTAVA E., JASEK O. Magnetic properties of gamma-Fe<sub>2</sub>O<sub>3</sub> nanopowder synthesized by atmospheric microwave torch discharge. *Acta Physica Polonica A*, 2012, 122(1), p. 9-11.
- ▶ GROEGER, R., VITEK, V. Constrained nudged elastic band calculation of the Peierls barrier with atomic relaxations. *Modelling and Simulation in Material Science and Engineering*, 2012, 20(3), 035019.
- ▶ JIRASKOVA Y., BURSÍK J., TUREK I. Nanostructure, composition and magnetic behaviour of mechanically alloyed Fe-Mo. *Journal of Superconductivity and Novel Magnetism*, 2012, 1(5), 10.1007/s10948-012-2049-4.
- ▶ DAVID B., PIZUROVÁ N., SCHNEEWEISS O., SANTAVA E., KUDRLE V., JASEK O. Gamma-Fe<sub>2</sub>O<sub>3</sub> nanopowders synthesized in microwave plasma and extraordinary strong temperature influence on their Mossbauer spectra. *Journal of Nanoscience and Nanotechnology*, 2012, 12(12), p. 9277-9285.

## Advanced Materials

### Advanced Ceramic Materials

- ▶ HADRABA, H., DRDLIK, D., CHLUP, Z., MACA, K., DLOUHY, I., CIHLAR, J. Laminated alumina/zirconia ceramic composites prepared by electrophoretic deposition. *Journal of the European Ceramic Society*. 2012, 32 (9), p. 2053-2056.
- ▶ KACHLIK, M., MACA, K., GOIAN, V., KAMBA, S. Processing of phase pure and dense bulk EuTiO<sub>3</sub> ceramics and their infrared reflectivity spectra. *Materials Letters*. 2012, 74(1), p. 16-18.
- ▶ SALAMON, D., MACA, K., SHEN, Z. Rapid sintering of crack-free zirconia ceramics by pressure-less spark plasma sintering. *Scripta Materialia*. 2012, 66(11), p. 899-902.
- ▶ GOIAN, V., KAMBA, S., PACHEROVA, O., DRAHOKOUPIL, J., PALATINUS, L., DUSEK, M., ROHLICEK, J., SAVINOV, M., LAUFEK, F., SCHRANZ, W., FUITH, A., KACHLIK, M., MACA, K., SHKABKO, A., SAGARNA, L., WEIDENKAFF, A., BELIK, A., A. Antiferrodistortive phase transition in EuTiO<sub>3</sub>. *Physical Review B*. 2012, 86(5), 9 p.
- ▶ BERA, O., TRUNEC, M. Optimization of Fine Alumina Gelcasting Using In Situ Dynamic Rheology. *Journal of the American Ceramic Society*. 2012, 95 (9), p. 2849-2856.

### Materials for Sensors and Technological Processes Control Systems

- ▶ HAVRANEK, Z., KLUSACEK, S. Experimental evaluation of methods for estimation of regularization in acoustic holography with MEMS sensor array. In *Inter-noise 2012*. New York, USA, 2012. p. 1-6.
- ▶ VACLAVEK, P., BLAHA, P., HERMAN, I. AC Drives observability analysis. *IEEE Transactions on Industrial Electronics*. 2012, Early Access Articles, p. 1-13.

## Advanced Metallic Materials and Metal Based Composites

- ▶ KUBENA, I., FOURNIER, B., KRUML, T. Effect of microstructure on low cycle fatigue properties of OGS steels. *Journal of Nuclear Materials*. 2012, 424(1), p. 101-108.
- ▶ KUNZ, L., LUKAS, P., KONECNA, R., FINTOVA, S. Casting defects and high temperature fatigue life of IN 713LC superalloy. *International Journal of Fatigue*. 2012, 41, p. 47-51.
- ▶ NAHLIK, L., HUTAR, P., DUSKOVA, M., DUSEK, K., MASA, B. Estimation of the macroscopic stress-strain of a particulate composite with a crosslinked polymer matrix. *Mechanics of Composite Materials*. 2012, 47(6), p. 627-634.
- ▶ REHAK, P., CERNY, M., POKLUDA, J. Dynamic stability of fcc crystals under isotropic loading from first principles. *Journal of Physics: Condensed Matter*. 2012, 24(21), 215403.
- ▶ SKLENICKA, V., DVORAK, J., KRAL, P., SVOBODA M., KVAPILOVA, M., LANGDON, T., G. Factors influencing creep flow and ductility in ultrafine-grained metals. *Materials Science and Engineering: A*. 2012, 558, p. 403-411.

## Structure and Phase Analysis

- ▶ CELKO, L., KLAKURKOVA, L., SLAMECKA, K., POSPISILOVA, S., JULIS, M., NEMEC, K., PODRABSKY, T., SVEJCAR, J. Structural stability of thermal barrier coatings produced by thermal spraying. In *METAL 2012 Conference proceedings*. Ostrava: TANGER, 2012. p. 394-399.
- ▶ JULIS, M., OBRTLÍK, K., POSPISILOVÁ, S., PODRABSKY, T., POLAK, J. Influence of AlSi diffusion coating on low cycle fatigue properties of cast superalloy Inconel 738LC at 800 °C. *Key Engineering Materials*. 2012, 488-489(1), p. 307-310.

## Structural Biology

### Bioinformatics

- ▶ HEGYI, H., TOMPA, P. Increased structural disorder of proteins encoded on human sex chromosomes. *Molecular Bio-systems*. 2012, 8(1), p. 229-236.

### CD Spectroscopy of Nucleic Acids and Proteins

- ▶ VORLICKOVA, M., KEJNOVSKA, I., SAGI, J., RENCIUUK, D., BEDNAROVA, K., MOTLOVA, J., KYPR, J. Circular dichroism and guanine quadruplexes. *Methods*. 2012, 57, p. 64-75.
- ▶ KYPR, J., KEJNOVSKA, I., BEDNAROVA, K., VORLICKOVA, M. Circular dichroism spectroscopy of nucleic acids. In *Comprehensive chiroptical spectroscopy: Application in stereochemical analysis and synthetic compounds, natural products, and biomolecules*. N. Berova, P.L. Polavarapu, K. Nakanishi, R.W. Woody. Eds. John Wiley & Sons. Inc., 2012. p. 575-586.

### CryoEM

- ▶ RIGORT, A., VILLA, E., BÄUERLEIN, F.J., ENGEL, B.D., PLITZKO, J.M. (2012) Integrative approaches for cellular cryo-electron tomography: correlative imaging and focused ion beam micromachining. *Methods Cell Biol.* 111, p. 259-281.
- ▶ RIGORT, A., BÄUERLEIN, F.J., VILLA, E., EIBAUER, M., LAUGKS, T., BAUMEISTER, W., PLITZKO, J.M. (2012) Focused ion beam micromachining of eukaryotic cells for cryoelectron tomography. *Proc. Natl. Acad. Sci. USA*. 109, p. 4449-4454.
- ▶ NEMECEK, D., QIAO, J., MINDICH, L., STEVEN, A.C., HEYMANN, J.B. (2012) Packaging accessory protein P7 and polymerase P2 have mutually occluding binding sites inside the bacteriophage  $\phi$ 6 procapsid. *J. Virol.*, 86, 11616.



- ▶ YOKOYAMA, T., SHAIKH, T.R., IWAKURA, N., KAJI, H., KAJI, A., AGRAWAL, R.K. (2012) Structural insights into initial and intermediate steps of the ribosome-recycling process. *EMBO J.* 31, p. 1836-1846.

## Glycobiology

- ▶ WIMMEROVA, M., KOZMON, S., NECASOVA, I., MISHRA, S.K., KOMAREK, J., KOCA, J. Stacking interactions between carbohydrate and protein quantified by combination of theoretical and experimental methods, *Plos One*, 2012, 7(10), e46032.

## RNA Quality Control

- ▶ KUBICEK, K., CERNA, H., HOLUB, P., PASULKA, J., HROSSOVA, D., LOEHR, F., HOFER, C., VANACOVA, S., STEFL, R. Serine phosphorylation and proline isomerization in RNAP II CTD control recruitment of Nrd1. *Genes & Development*. 2012, 26(17), p. 1891-1896.
- ▶ HOLUB, P., LALAKOVA, J., CERNA, H., PASULKA, J., SARAZOVA, M., HRAZDILOVA, K., SANUDO, M. A., STEFL, R., VANACOVA, S. Air2p is critical for the assembly and RNA-binding of the TRAMP complex and the KOW domain of Mtr4p is crucial for exosome activation. *Nucleic Acids Research*. 2012, 40(12), p. 5679-5693.

## Nanobiotechnology

- ▶ SKLADAL, P., SVABENSKA, E., ZERAVIK, J., PRIBYL, J., SISOVA, P., TJARNHAGE, T., GUSTAFSON, I. Electrochemical immunosensor coupled to cyclone air sampler for detection of Escherichia coli DH5alpha in bioaerosols. *Electroanalysis*. 2012, 24(3), p. 539-546.
- ▶ HLAVACEK, A., SKLADAL, P. Isotachophoretic purification of nanoparticles: Tuning optical properties of quantum dots. *Electrophoresis*. 2012, 33(9-10), p. 1427-1430.

## Biomolecular NMR Spectroscopy

- ▶ NOVÁČEK, J., HABA, N.Y., CHILL, J.H., ZÍDEK, L., SKLENÁŘ, V. 4D non-uniformly sampled HCBCACON and <sup>1</sup>J(NCα)-selective HCBCANCO experiments for the sequential assignment and chemical shift analysis of intrinsically disordered proteins. *Journal of Biomolecular NMR*. 2012, 53(2), p. 139-148.
- ▶ PAVLÍKOVÁ, N., BLÁHOVÁ, L., KLÁN, P., BATHULA, S.R., SKLENÁŘ, V., GIESY, J.P., BLÁHA, L. Enantioselective effects of alpha-hexachlorocyclohexane (HCH) isomers on androgen receptor activity in vitro. *Chemosphere*. 2012, 86(1), p. 65-69.

## RNA-based Regulation of Gene Expression

- ▶ HERRMANNOVA, A., DAUJOTYTE, D., YANG, J. C., CUHALOVA, L., GORREC, F., WAGNER, S., DANYI, I., LUKAVSKY, P. J., VALASEK, L. S. Structural analysis of an eIF3 subcomplex reveals conserved interactions required for a stable and proper translation pre-initiation complex assembly. *Nucleic Acids Research*. 2012, 40(5), p. 2294-311.

## Structural Biology of Gene Regulation

- ▶ SIKORSKY, T., HOBOR, F., KRIZANOVA, E., PASULKA, J., KUBICEK, K., STEFL, R. Recognition of asymmetrically dimethylated arginine by TDRD3. *Nucleic Acids Research*. 2012, 40(22), p. 11748-11755.
- ▶ KUBICEK, K., CERNA, H., HOLUB, P., PASULKA, J., HROSSOVA, D., LOEHR, F., HOFER, C., VANACOVA, S., STEFL, R. Serine phosphorylation and proline isomerization in RNAP II CTD control recruitment of Nrd1. *Genes & Development*. 2012, 26(17), p.1891-1896.



- ▶ PORRUA, O., HOBOR, F., BOULAY, J., KUBICEK, K., D'AUBENTON-CARAFI, Y., GUDIPATI, R. K., STEFL, R., LIBRI, D. In vivo SELEX reveals novel sequence and structural determinants of Nrd1-Nab3-Sen1-dependent transcription termination. *EMBO J.* 2012, 31, p. 3935-3948.

## Structural Virology

- ▶ PLEVKA, P., PERERA, R., CARDOSA, J., KUHN, R.J., ROSSMANN, M.G. Crystal Structure of the Hand, Foot, and Mouth Disease Virus, Enterovirus 71. *Science.* 2012; 336(6086):1274.

## Structure and Dynamics of Nucleic Acids

- ▶ SPONER, J., CANG, X.; CHEATHAM, T., E., III. Molecular dynamics of G-DNA and perspectives on the simulations of nucleic acids. *Methods.* 2012, 57(1), p. 25-39.
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## 3.5 Common Evaluation of Scientific Excellence



The first independent evaluation of scientific excellence in CEITEC was held on June 2012. More than twenty top experts from leading scientific institutions from around the world arrived in Brno in order to evaluate the work of over 400 scientists from CEITEC. CEITEC organized evaluations of scientists solely by foreign experts, which guarantees truly independent and transparent evaluations. The aim was to gain an unbiased picture of the current state of affairs and to receive recommendations from those eminent in the field that could be implemented in individual Research Groups.

An independent evaluation by external assessors is part of the long-term strategy of the centre's management as well as being beneficial to the centre's international standing. During the preparation of the whole evaluation process CEITEC found inspiration abroad, mainly at the Belgian VIB institute. Individual evaluation committees for each Research Programme were chaired directly by members of the International Scientific Advisory Board of CEITEC or by other experts from prestigious institutions.

The chairs of the evaluation boards were:

- **Herbert Störi**, Institute of Applied Physics, Technical University of Vienna – RP 1 Advanced Nano- and Micro-technologies
- **Wolfgang Knoll**, Austrian Institute of Technology – RP 2 Advanced Materials
- **Hartmut Oschkinat**, Leibnitz Institute for Molecular Pharmacology Berlin – RP 3 Structural Biology
- **Dirk Inzé**, Vlaams Instituut voor Biotechnologie – RP 4 Genomics and Proteomics of Plant Systems
- **Andrés Aguilera**, Andaluzian Center for Molecular Biology and Regenerative Medicine – RP 5 Molecular Medicine
- **Christoph Michel**, University of Geneva – RP 6 Brain and Mind Research
- **Darren K. Griffin**, School of Biosciences University of Kent – RP 7 Molecular Veterinary Medicine





The system of evaluation consisted of three parts. Firstly, standard results for scientific work, the quality of published outputs, cooperation with the application sphere and success in getting international grants were evaluated. The evaluation was exacting. For example, any publications falling below the median in the relevant field were not included in the evaluation and, in contrast, the most prestigious journals were assigned a higher evaluation weighting. In the second part, individual research groups were compared to the relevant top teams in their fields in prestigious research institutes in Europe – namely Imperial College London, VIB (Vlaams Instituut voor Biotechnologie) in Belgium, EMBL (The European Molecular Biology Laboratory) based in Heidelberg in Germany and the Hebrew University of Jerusalem in Israel. In the third part there were personal interviews by scientists with the evaluators, who, apart from the overall vision and goals of the group, also evaluated the ability of Group Leaders to convince them that in future they can truly attain top results and bring the level of science at CEITEC closer to the best research centres. The ability and clear plans of the Research Group Leaders to ensure support and growth for young talents was also essential. Finally, reports from all parts were summed up, which will provide a quantifiable reply as to how the given team is doing and includes very important recommendations which will be implemented in the coming years. The next evaluations will then take place at 2014, 2016 and 2020. Subsequent evaluations will take place in four-year intervals.

The final results turned out to be positive for CEITEC. As Professor Wolfgang Knoll, the Scientific Director of the Austrian Institute of Technology and the Chairman of the CEITEC International Scientific Advisory Board mentioned the first evaluation showed that some research groups can already rank among the European elite and most researchers recruited by CEITEC definitely had the potential to achieve that level. Over a 5 to 10-year timeframe CEITEC should be the one of the leading European centres.



### Results\*:

Overview	Number of RGs	Percentage
A1	8	15%
A2	12	23%
A3	6	11%
B	16	30%
C	11	21%
D	0	0%
<b>Total</b>	<b>53</b>	<b>100%</b>

\*The results were presented in line with the ERC classification, i.e. using a scale from A (excellent) to D (unsatisfactory). In addition, group A has 3 subcategories (A1, A2 and A3).

## 3.6 Research infrastructures

### Czech scientists are part of Instruct

Breakthroughs in biomedical science are a step closer with the launch of “Instruct”, a new European infrastructure in the field of structural biology. CEITEC MU joined the project as the representing partner from the Czech Republic. The Czech Republic is among the first eight countries to become involved in the establishment of Instruct; the founding agreement was signed on 23<sup>rd</sup> February 2012. As a result, scientists from participating countries will benefit from the use of the most advanced technologies. All Czech scientists in the field of structural biology will be able to access the very best technology and use unique technologies and facilities in any of the participating countries. With the cooperation of the leading European scientific institutes in the field of structural biology, Instruct will provide academic scientists and commercial entities with access to facilities and technologies. This puts us in an exclusive club of leading institutes and experts in the field. The status of an Instruct affiliated national centre will be held by the Czech Integrated Infrastructure for Structural Biology (CIISB), which joins the Structural Biology Laboratories of the CEITEC centre and the Centre of Molecular Structure of the BIOCEV centre. It provides the Czech scientific community with the possibility of “open access” to the latest technologies and information from the field.



### CEITEC is part of Czech node of ELIXIR

New technologies such as next-generation sequencing cause that data about DNA, proteins and other molecules structure (i.e., bioinformatics data) is doubling every few months. The data are very useful and valuable, but such a volume of information cannot be handled by one institute or one country. For this reason, the European Strategy Forum on Research and Innovation (ESFRI) initiated establishment of pan-European bioinformatics infrastructure ELIXIR.



The goal of this distributed infrastructure is to ensure that bioinformatics data are kept safe and made easily accessible. Till now, ELIXIR leadership body was formed and 13 countries joined ELIXIR. Also Czech Republic joined ELIXIR – at 3<sup>rd</sup> September 2012. As a next step, ELIXIR announced a call for proposals of its national parts (so called national nodes). In Czech Republic, CEITEC together with UOCHB (a Czech ELIXIR coordinator) and 5 other Czech life science and IT organizations accepted this challenge. They together established a Czech ELIXIR node as a distributed infrastructure, focused on handling of Czech bioinformatical data and software tools.

A big part of this node is located in Brno. Specifically, there will be for example storage of human genome data focused on hematological and oncological diseases. Moreover, in the ELIXIR node, CEITEC connects its IT resources with CERIT-SC – a large IT provider and tool developer also located in Brno. CEITEC and CERIT-SC together offer a set of tools for processing of genome data. These tools can be executed on the same site where the size extensive genome data are stored, leveraging direct access to these data without the need to copy them elsewhere.

## 3.7 Core Facilities

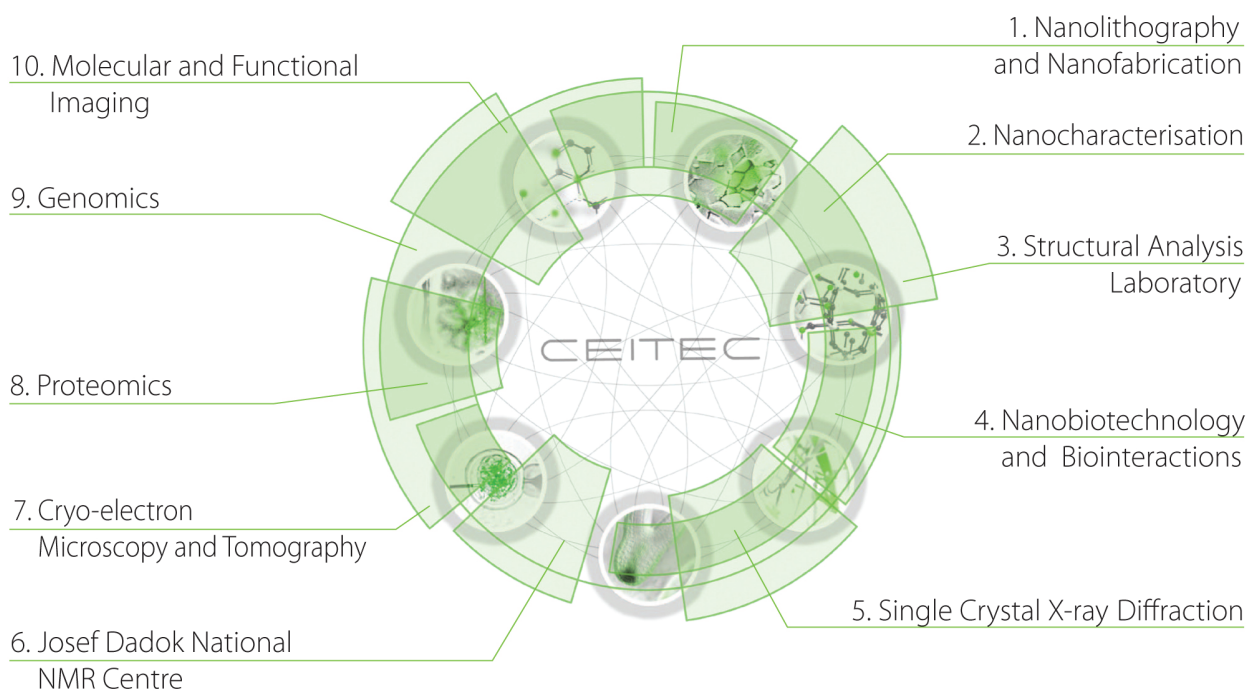
The CEITEC Core Facilities will offer access to cutting-edge, often expensive equipment to the research community. Our goal is to be a central hub for shared resources that provide the academic and industrial scientific investigators not only use of instrumentation, but also technology development and service.

The Core Facilities will be established in two locations in Brno:

The campus of Masaryk University in Brno - Bohunice, the centre of life sciences and biomedicine, benefits from being near the Faculty Hospital in Brno and the INBIT Biotech incubator.

The Brno University of Technology campus in Brno Pod Palackého vrchem, the centre for material science and advanced technologies, neighbours the Czech Technology Park and comprises INMEC.

All CEITEC Core Facilities are available to external users (academia and companies). Czech and international researchers from universities and research institutes interested in accessing Core Facilities can benefit from support of CEITEC – open access project funded by the Ministry of Education, Youth and Sports of the Czech Republic. International users of Josef Dadok national NMR centre can be supported by Bio-NMR project funded by 7<sup>th</sup> Framework Programme.



## Nanolithography and Nanofabrication

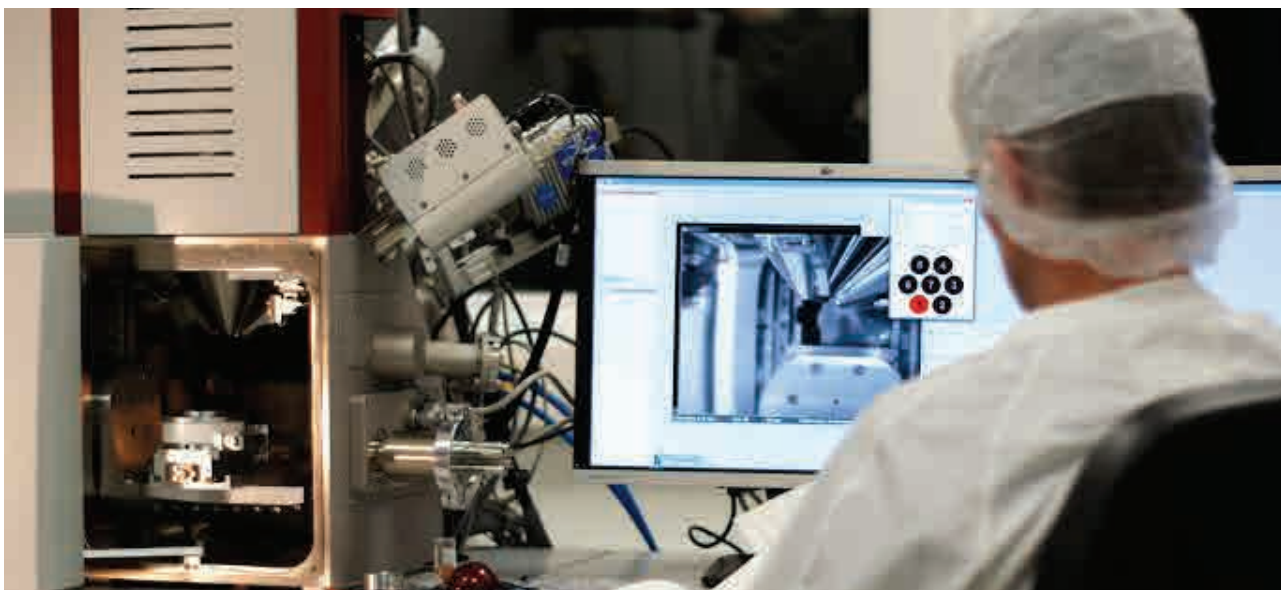
Head of Core Facility: Tomáš Šikola

News in 2012: In addition to the already existing tools, scanning electron microscope combined with focused ion beam (FIB) has been purchased and installed. Tenders for purchasing of an atomic layer deposition system (ALD), lithographic scanning electron microscope and wire bonding system have been finished successfully, with instruments to be delivered in the 2<sup>nd</sup> quarter of 2013.

The works on the more detailed specification of the clean room facility, built-in technologies and instruments continued.

The Core Facility is designed for fabrication of nanostructures by lithographic methods (top-down approach) and by self-assembly methods (bottom-up approach). All necessary technological steps for the fabrication of functional nanodevices (design, lithography, metallization, sputtering, packaging, and testing) will be available to the Core Facility users. Advanced methods for the guided growth (self-assembly) of the nanostructures will also be at their disposal and their interconnection with classical lithography techniques will be possible.

The clean room laboratory (class 100 – 1 000) equipped with the state-of-the-art techniques for the nanofabrication of nanostructures enables an effective fabrication of all kinds of nano- and microstructures and devices in one facility. Together with the Nanocharacterisation Core Facility it offers a unique combination of techniques providing both the fabrication and diagnostics of complex functional nanostructures and nanodevices.





## Nanocharacterisation

Head of Core Facility: Josef Humlíček

News in 2012: In addition to the already existing tools new instruments have been purchased and installed. It covers optical microscope suitable for observing lithographic structures, spectroscopic reflectometer, and FT-IR microscope. Additionally, a scanning near-field optical microscope, scanning probe microscope combined with a mRaman spectrometer and two spectroscopic ellipsometers for the UV/VIS and IR ranges will be available in the 1<sup>st</sup> quarter of 2013. The works on the more detailed specification of the clean room facility, built-in technologies and instruments continued.

The Core Facility is designed for characterisation of surfaces and nanostructures by various analytical methods. It also includes complex facilities for in-situ investigation of the processes responsible for the growth of thin films and self-assembling nanostructures.

The clean room laboratory (class 1 000 – 100 000) equipped with the state-of-the-art techniques for characterisation of nanostructures provides an effective characterization and analysis of all types of nano- and microstructures and devices.





## Structural Analysis Laboratory

Head of Core Facility: Jiří Švejcar

News in 2012: Advanced structural methods include as an integral part the X-Ray diffraction methods, for which the Core Facility has, as of February 2013, at its disposal two top-class diffractometers from the Japanese company Rigaku. Powder diffractometer SmartLab 3kW with standard Cu anode and variable additional equipment such as eulerian cradle, parallel beam optics, germanium monochromators, small-angle scattering unit, X-Y mapping table, high- and low-temperature vacuum chambers and reactive chamber allows performing advanced applications, for example x-ray reflectivity, rocking curve, small-angle x-ray scattering, in-situ measurement, etc. Diffractometer SmartLab 9kW, dedicated to the study of planar structures, is equipped with a rotating 9kW Cu anode and in-plane goniometer. It is designed primarily for the measurement of ultra-thin layers and reciprocal-space mapping. The system also allows, for example, SAXS measurements with a resolution of up to 100 nm.

The Core Facility provides for advanced structural studies by means of high-resolution transmission electron microscopy (including local chemical analysis and diffraction) and high resolution scanning electron microscopy (including local elemental analysis and electron backscatter diffraction) both in high and low vacuum, surface modification (machining, layer deposition) by ion beam, and precise manufacturing of TEM foils by ion beam.

Highly advanced materials imaging at the atomic scale level will be available coupled with the availability of highly sensitive chemical analysis at the nano-scale level. It will be possible to observe and analyse both conductive and non-conductive bulk specimens of technical materials in terms of chemistry and crystallography without coating. High-resolution imaging, analysis and ion beam manipulation as well as advanced TEM sample preparation techniques will be possible.

## Biomolecular Interaction

Head of Core Facility: Michaela Wimmerová

News in 2012: In November 2012, the automatic system for isothermal titration calorimetry, Auto ITC200, was installed. Routines, scripts and rules to operate the system in CF mode have been prepared. First two months of 2013 will serve as a test period to modulate needs of individual users. The machine will be operated by two technicians; sample sheets will be prepared for each measurement. The apparatus will be fully operational and open to all individuals both from inside and outside users since March 2013. Expertise with data evaluation and data evaluation training is guaranteed by three experienced scientists.

The Core Facility provides for methodologies for scanning probe imaging of biological samples ranging from individual molecules to tissues, nanomanipulations and nanolithography, immobilisation and modification techniques, biosensor and calorimetry-based investigation of biomolecular interactions in real time.

The successful application of nanobiotechnologies and biosensor-related techniques in biology requires a multidisciplinary knowledge in biochemistry, biophysics, bioorganic chemistry, material science, electronics and image analysis. Centralised organisation of instrumentation and a team of experienced researchers will ensure expert services for untrained users and the cost-effective use of resources. Benefits include simple access to promising nano-methods, shortened preliminary experimentation and the quick generation of high-quality data.

## Single Crystal X-ray Diffraction

Head of Core Facility: Jaromír Marek

News in 2012: Core Facility offered current equipment maintained by the Glycobiology Research Group to at least partially cover needs of internal and external users in protein crystallization. The instrumentation, albeit with lower capacity and more manual work, includes automation robotics for crystal setup, storage capacity and inspection system with UV monitoring. The CF offers setup of more than 600 crystallization conditions for screening, which can be enhanced over 1300 after being fully operable. In connection with diffractometers installed in 2013 the Core Facility will be able to evaluate diffraction properties of prepared crystals.

Changes in available instrumentation had enabled us to expand the range of methodologies used by originally "single crystal only" CF into area of the Small Angle X-ray Scattering (SAXS) with biomacromolecular samples in solution. All X-ray instrumentation for SAXS and single crystal diffraction experiments had been selected during 2012 and are installed now (February 2013).

The Core Facility provides for diffraction experiments with single crystal samples focused on determining the 3-D structure of (macro)molecules down to atomic resolution. Range of applicable molecular mass: from 102 up to 106, where the lower value covers molecules significant for nanotechnology, material science or pharmacology and upper limit covers biomacromolecules such as nucleic acids, proteins and their complexes. Automated screening of crystallization conditions, optimisation of protein crystals growth.

The diffraction of X-rays in single crystal samples is the most important and – if an appropriate sample is available – also the fastest methodology currently available for the determination of atomic structures of molecules and/or macromolecules and their complexes. The Faculty of Science at Masaryk University has almost 20 years of experience with the diffraction laboratory focussed on small molecules. The new Core Facility is a coherent extension to new, macromolecular and biological studies of subjects with higher molecular masses. The bottleneck in diffraction techniques – time consuming preparation of protein crystals – will be overcome using a highly automated high throughput infrastructure for protein growth preparation, monitoring, and analysis. Centralised organisation of this instrumentation allows cost-effective use of resources and the exploitation of results even for untrained users.

## Josef Dadok National NMR Centre

Head of Core Facility: Radovan Fiala

News in 2012: Five NMR spectrometers with proton operation frequencies from 500 MHz to 950 MHz were installed and put into operation in the period between June and October 2012. Since November of 2012 the Core Facility has been operational with the above mentioned instruments. Official opening of the facility took place on January 23<sup>rd</sup>, 2013, followed by a scientific symposium on January 24<sup>th</sup>.

The Core Facility provides for investigation of the biomolecular structure and dynamics by NMR spectroscopy. Development of novel methodologies for biomolecular NMR spectroscopy (development of new pulse sequences with improved sensitivity and resolution, development of methods providing additional structural restraints, improvement of strategies for three-dimensional structure calculations and for analysis of the relaxation data in terms of biomolecular dynamics).

NMR (Nuclear Magnetic Resonance) spectroscopy is a key technology for research in modern life sciences allowing detailed investigation of biomolecular structure and dynamics at the atomic level, both in solutions and in solid state. The successful application of NMR in biology requires multidisciplinary approach combining knowledge in biochemistry, molecular biology, quantum physics, electronics, data analysis, and computational chemistry. The high-end instrumentation and the team of experienced researchers will ensure expert services, user training, and the cost-effective use of resources both for internal and external users. Benefits include access to state-of-the-art high-field NMR instrumentation and support in processing, analysis and interpretation of the experimental data.



## Cryo-electron Microscopy and Tomography

Head of Core Facility: Jürgen Plitzko

News in 2012: The Core Facility has been fully staffed with onset of its working activities in January 2013. Two experienced researchers Daniel Němeček, PhD. and Tanvir Shaik, PhD. have been hired. The equipment for the Core Facility has been tendered with the expected delivery at the beginning of 2014.

Modern electron microscopy in structural biology on the cellular and molecular level is performed by cryo-electron microscopy and cryo-electron tomography. Cryo-electron tomography (cryo-ET) is the only method to address pleiomorphic structures like cells and organelles in a close to native state, while cryo-electron microscopy (cryo-EM) is applied to study single particles, primarily larger macromolecular complexes, which have been isolated and purified by biochemical methods. Both methodologies provide information on the cellular and molecular level and are therefore ideal for in-depth structural-functional analysis in combination with state of the art biochemical characterisation. The main activities of the Core Facility will be centred on application of cryo-EM and cryo-ET, implementations of the required image processing capabilities, and explorations of suitable cryo-preparation techniques.

The main objective of the Core Facility is to establish a world-class facility for cryo-electron microscopy accessible also for external users. The centre will provide access to EM instrumentation set up for high-throughput image acquisition for single particle analysis as well as for the acquisition of cellular cryo-electron tomograms. Moreover, it will provide assistance to external users/collaborators in image processing (e.g. 3-D reconstruction, denoising, pattern recognition, segmentation, visualization). External user projects will be selected by peer review on the basis of scientific merit, technical suitability and feasibility.

## Proteomics

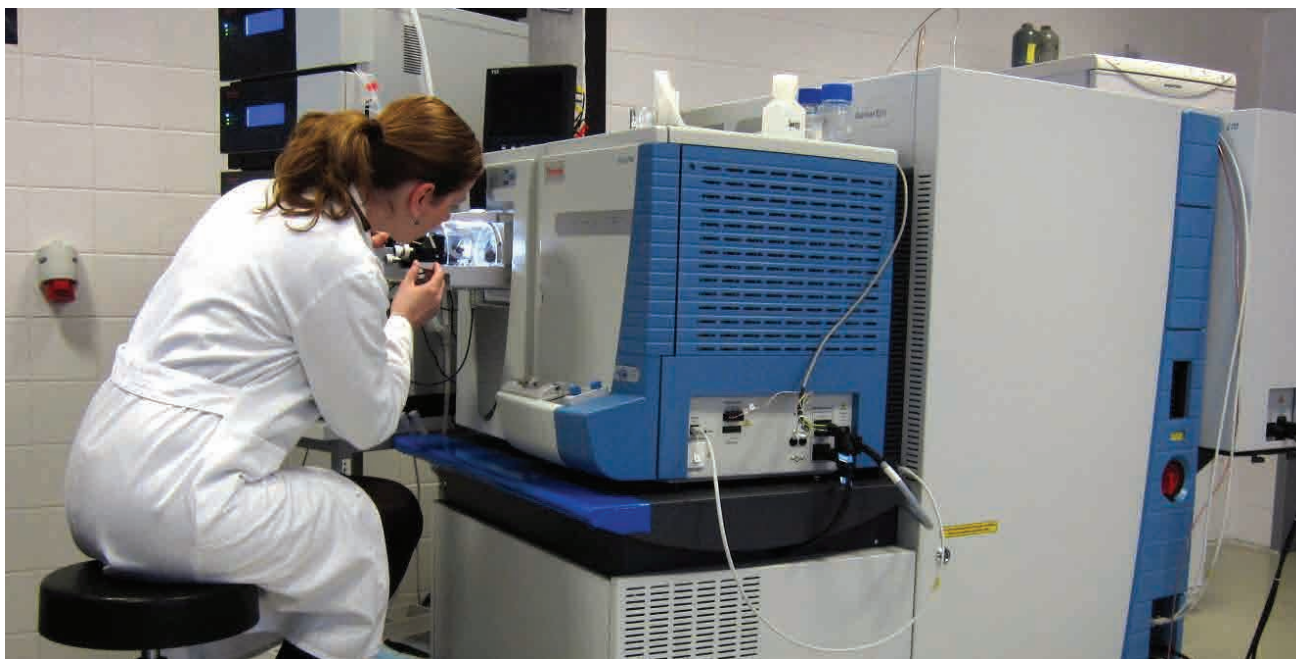
Head of Core Facility: Zbyněk Zdráhal

News in 2012: Installation of new LC-MS/MS system with high resolution hybrid mass spectrometer Orbitrap ELITE - this instrumentation substantially improves our capabilities in analysis of complex protein samples in terms of sensitivity and sample coverage, it enables application new techniques for relative quantitation and characterization of posttranslational modification.

Installation of new LC-MS/MS system with hybrid mass spectrometer QTRAP 6500 - This type of instrumentation extends our application area with targeted proteomics methodology. It enables quantitation of selected proteins (e.g. marker proteins) with unsurpassed sensitivity.

New contacts were established with two international proteomics laboratories – Functional Genomics Center in Zurich (successful application within the frame of the project PRIME XS) and Proteomic Core Facility at Medical University of Vienna

The Core Facility provides for mass spectrometry – based proteomics. Activities of the Core Facility cover all steps of proteomic analysis – protein isolation, separation of protein mixtures, protein characterisation by mass spectrometry and bioinformatics data processing.



## Genomics

Head of Core Facility: Boris Tichý

News in 2012: In 2012 DNA microarray scanner and 8-capillary DNA sequencer were acquired. Tenders for two benchtop massively parallel sequencers were started (both finished successfully in the beginning of 2013). Access to the instruments and services based on them will be offered since 2<sup>nd</sup> quarter of 2013. instruments will be placed in provisional location in Masaryk university Campus.

The Core Facility provides for application of new high-throughput methods into basic and applied research, and development and optimisation of methods for genomic analyses.

Combination of high-end equipment and expertise for the complete experimental workflow from advanced sample preparation to complex genome analysis. Precise sample preparation techniques (cell sorting, microdissection) followed by combination of various complementary approaches in the analysis of the genome (massive parallel sequencing, microarrays, quantitative PCR) will make it possible to perform even very complex experimental designs including single cell genomics or diseased vs. healthy cells genome and transcriptome analyses.



## Molecular and Functional Imaging

Head of Core Facility: Ivan Rektor

News in 2012: The Core Facility is involved in two consortia preparing 7FP projects. The co-operation with Hospital Universitaire Geneve has started with implementing the methodology of concurrent scalp and depth structure EEG recording. This technique is being developed also in sight of the acquisition the HD-EEG (256 channel) machine in 2013. The methods of ASL and DTI has been introduced, so far on the hospital MRI, in order to be prepared for the new CF-MRI equipment.

The Core Facility provides for methodologies for in-vivo magnetic resonance imaging (MRI) and magnetic resonance spectroscopy (MRS) of human, animal and plant tissues with spatial resolution reaching to 0.1 mm, with the main application in functional (fMRI) and molecular imaging (mMRI) of the brain.

Basic as well as applied research in medicine (human and animal) including pharmacology, molecular and cell biology requires in-vivo insight into live organs and tissues as a very important part of a multi-level and multidisciplinary approach. Modern MRI methods make it possible to visualise the anatomical structures of living objects, but also to discover their functional organisation and the chemical mechanisms underlying health and disease. Currently an effort is put in tracking their dynamics, to multimodal imaging (such as by combining MR with electrophysiology or transcranial magnetic stimulation), and to visualise biological processes at the cellular and molecular levels using molecular MRI by employing targeted contrast agents, spectroscopic imaging, diffusometry or relaxometry. The intended infrastructure will be also used for technological and methodological research aiming to improve existing imaging methods or to develop new methods and data processing strategies for the study of animate as well as inanimate matter, thus establishing a bridge between life and material sciences.

## 4.1 New CEITEC Executive Director

From November 2012, the new executive director of CEITEC is to be Markus Dettenhofer. He was successful against a range of foreign candidates in an international selection process. This experienced manager in the science and research field is a trained at prestigious universities such as University of California at Berkley and Harvard. His priority is to make CEITEC an internationally recognised scientific centre that will attract other top scientists. In the management of CEITEC, Dettenhofer replaces Tomáš Hruša, who has taken the position of Deputy Czech Minister of Education.

Markus Dettenhofer studied microbiology and immunology at the renowned University of California at Berkley and gained his Ph.D. in molecular microbiology and immunology at Johns Hopkins University. He undertook post-doctoral studies in genetics at Harvard Medical School. Before joining CEITEC he led research projects in the company Crucell (Johnson & Johnson) focussing for example on the search for viral vaccines and antibodies. He has worked in both the academic environment and in the biotechnology industry, gaining significant experience in running international scientific projects, as well as the transfer of technologies and marketing. He is also the author of a range of peer-reviewed publications.

## 4.2 Coordination Board

Coordination Board is the highest authority of the Centre. It has been operational since December 2009 and from the end of 2010 meets on a quarterly basis (March, June, September, and December). The Board approves the Governing Documents (including among others the budget of the Central Management Structure), Common Rules and Policies and makes other key decisions, such as the approval of nominations for the Executive and Scientific Director. Coordination board is composed of representatives of project partners and external representatives.



### Nominated Members in 2012 – statutory representatives:

1. Assoc. Prof. PhDr. **Mikuláš Bek**, Ph.D., rector, Masaryk University
2. Prof. Ing. **Karel Rais**, CSc., MBA, rector, Brno University of Technology
3. Prof. Ing. **Jaroslav Hlušek**, CSc., rector, Mendel University in Brno
4. Prof. MVDr. **Vladimír Večerek**, CSc., MBA, rector, University of Veterinary and Pharmaceutical Sciences Brno
5. Prof. RNDr. **Ludvík Kunz**, CSc., dr. h. c., director, Institute of Physics of Materials
6. Prof. MVDr. **Břetislav Koudela**, CSc., director, Veterinary Research Institute

### Expert Representatives in 2012:

1. Prof. **Gustaaf Borghs**, IMEC Fellow, Full professor at Katholieke Universiteit Leuven, Belgium
2. Prof. **Stefan Maier**, Co-Director of Centre for Plasmonics & Metamaterials, Imperial College London, UK
3. Ing. **Jaroslav Doležal**, CSc., National Executive, Honeywell, Czech Republic
4. Prof. RNDr. **Vladimír Král**, DSc., API Development Director, Zentiva, Prague, Czech Republic, till the end of 2012

### Guests in 2012:

Governor of SM, Mayor of Brno, JIC Executive Director

## 4.3 International Scientific Advisory Board

International Scientific Advisory Board is the highest scientific advisory body of the Centre. It meets twice a year, at least once physically in Brno. The Board plays a crucial role in the Common Evaluation of Scientific Excellence as it sets the criteria, comments on the planned research activities and gives recommendations regarding strategic positioning of the Centre.

ISAB Members in 2012:

1. Prof. **Andrés Aguilera**, Head of Molecular Biology Department and Scientific Vice-director, Andalusian Centre for Molecular Biology and Regenerative Medicine (CABIMER), Seville, Spain
2. Prof. **Dirk Inzé**, Scientific Director and Department Director, Flanders Institute for Biotechnology, Department of Plant Systems Biology, Gent, Belgium
3. Prof. **Wolfgang Knoll**, Managing Director, Austrian Institute of Technology, Vienna, Austria, Chairman of ISAB
4. Prof. **Christoph M. Michel**, Director, Functional Brain Mapping Laboratory, Department of Fundamental Neurosciences, University Medical School, Geneva, Switzerland
5. Prof. **Yoshio Nishi**, Director of Research, Center for Integrated Systems, Stanford University, Palo Alto, USA
6. Prof. **Hartmut Oschkinat**, Scientific Director, Leibniz Institute for Molecular Pharmacology, Berlin, Germany



INTERNATIONAL SCIENTIFIC  
ADVISORY BOARD



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