CEITEC

Central European Institute of Technology

BRNO | CZECH REPUBLIC

EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND
INVESTING IN YOUR FUTURE

2007–13
OP Research and Development for Innovation

Introductory Word

Ladies and Gentlemen,

The Central European Institute of Technology – CEITEC, is located in Brno, the city of Johann Gregor Mendel. Brno is one of the most innovation-friendly cities in Europe. As such the city and the region combine their wonderful scientific heritage with a bright future.

CEITEC aims to capitalise on the exciting opportunities stemming from a unique integration of Life and Material Sciences. This integration will generate great potential for a wide variety of interdisciplinary discoveries and help to transfer them into real life applications faster and more effectively.

Creativity and experimentation is at the heart of our research activities, even so the management and assessment of our work will rely on internationally proven models. Regular independent evaluations, engagement of internationally renowned experts and a strong focus on top quality scientific outputs will be an integral part of CEITEC's DNA.

CEITEC is naturally very ambitious, however the responsibility placed on our shoulders by the enormous resources that have been made available for this project is not lost on us. The goal of our centre is therefore to provide our partners and innovation-focussed companies with best quality services – from the use of our state of the art infrastructure to long-term collaborative research. Our centre aims to provide our parent institutions, the city and the region with top quality research and expertise. CEITEC is proud to be playing a crucial role in the long-term prosperity of the region.

Tomáš Hruda, Executive Director

CEITEC
Central European Institute of Technology

CEITEC is a centre of scientific excellence in the fields of life sciences and advanced materials and technologies whose aim is to establish itself as a prestigious European centre of science with a state-of-the-art infrastructure and conditions in place to employ the best researches available. It is a consortium whose partners include the most prominent universities and research institutes in Brno, and it benefits from the support of the Region of South-Moravia and the City of Brno.

The Centre will feature modern laboratories with state-of-the-art instrumentation, technologies and infrastructure, which will ensure suitable conditions for conducting both basic and applied research.

CEITEC

- European centre of scientific excellence integrating research in life sciences, advanced materials and technologies.
- Unique technologies, state-of-the-art infrastructure, specialized laboratories and core facilities for both basic and applied research.
- An encouraging environment for nearly six-hundred researchers, twelve-hundred students and hundreds of innovative companies both from the region and abroad.

Vision

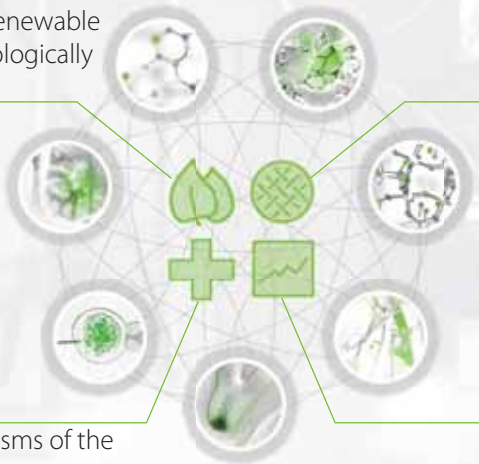
We create a centre of scientific excellence whose results will contribute to an improvement in the Quality of Life and Human Health.

Common Research Goals

CEITEC is based on the synergy of seven research programmes, whose activities aim to attain the four common research goals:

To utilize plant systems as renewable sources of materials and biologically active compounds

To develop advanced materials and functional nanostructures for medicine, energy and information and communication technologies



To understand the mechanisms of the genesis and spreading of important diseases, methods of their prevention, early diagnostics and therapy

To utilize information and communication technologies for biomedicine

Basic Overview

- **6** partners
- **7** research programmes
- **63** research groups
- **557** researchers (2015)
- **25,000 m^2** of new laboratories
- **10** Core Facilities
- Total budget of **€ 208 mil.**
- CEITEC was **approved by the European Commission on 6th June 2011**
- Start of research activities: **Q1 2011**
- Project completion: **Q4 2015**

- **Interdisciplinary cooperation**
- The combined knowledge and resources of the six participating institutions will ensure more efficient attainment of quality results and higher levels of involvement from the application sphere.

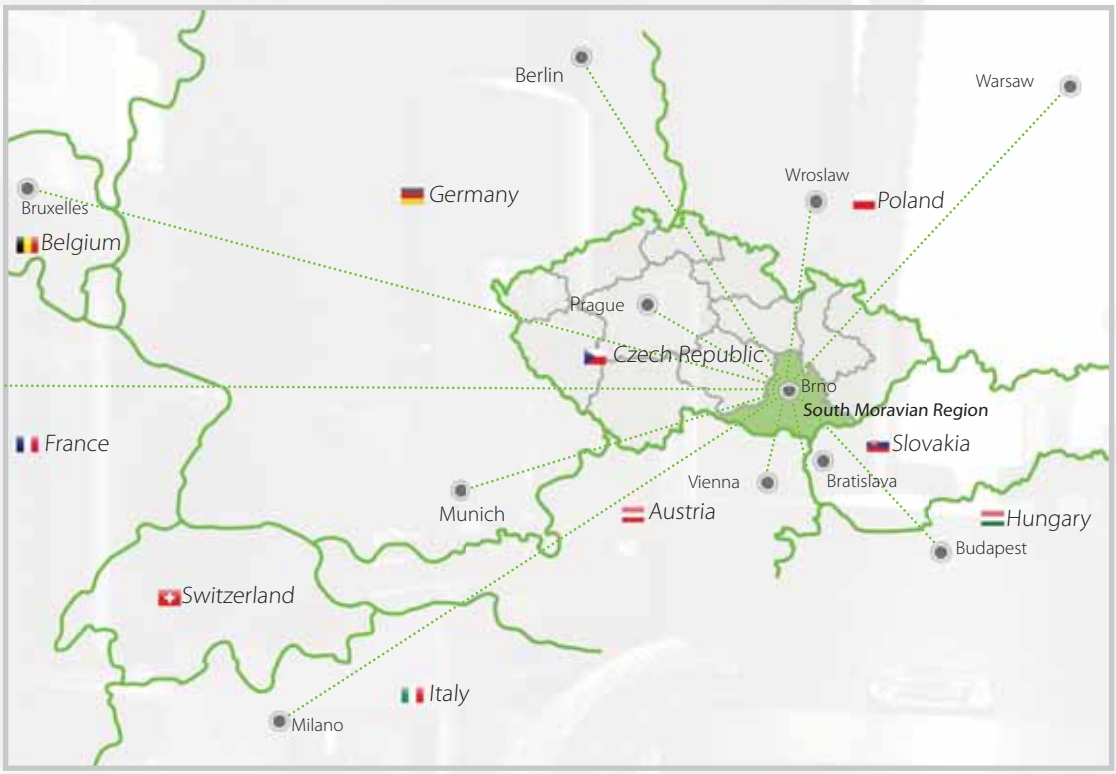
- **International management**
- International mobility and a system of management gained from the experience of the best research institutes worldwide
- Coordination Board – composed of representatives from prominent Czech firms in R&D fields and representatives from the best international research institutes
- International Scientific Advisory Board – members are exclusively representatives of important international research institutes
- Evaluations of the quality of research results are conducted by independent teams of prominent global experts in their respective fields
- English as the internal language of business

Benefits to the Region

- Improvement in student education – predominantly in graduate studies
- Research laboratories for nearly 600 scientists and more than 1200 students
- Creation of new innovative firms and the attraction of domestic and international investors
- Creation of new jobs in the respective fields of research
- Attraction of foreign experts and respected Czech scientists to the area

CEITEC will significantly contribute to the long-term increase in the competitiveness of Brno, the Region of South-Moravia and the Czech Republic as a whole.

Location



Financing

Total budget of **€ 208 mil.**

Source of funding: The European Regional Development Fund to be financed through the Operational Programme Research and Development for Innovations, priority axis 1 – European Centres of Excellence, which is managed by the Ministry of Education, Youth and Sports of the Czech Republic.

Partnering Institutions

Masaryk University
www.muni.cz

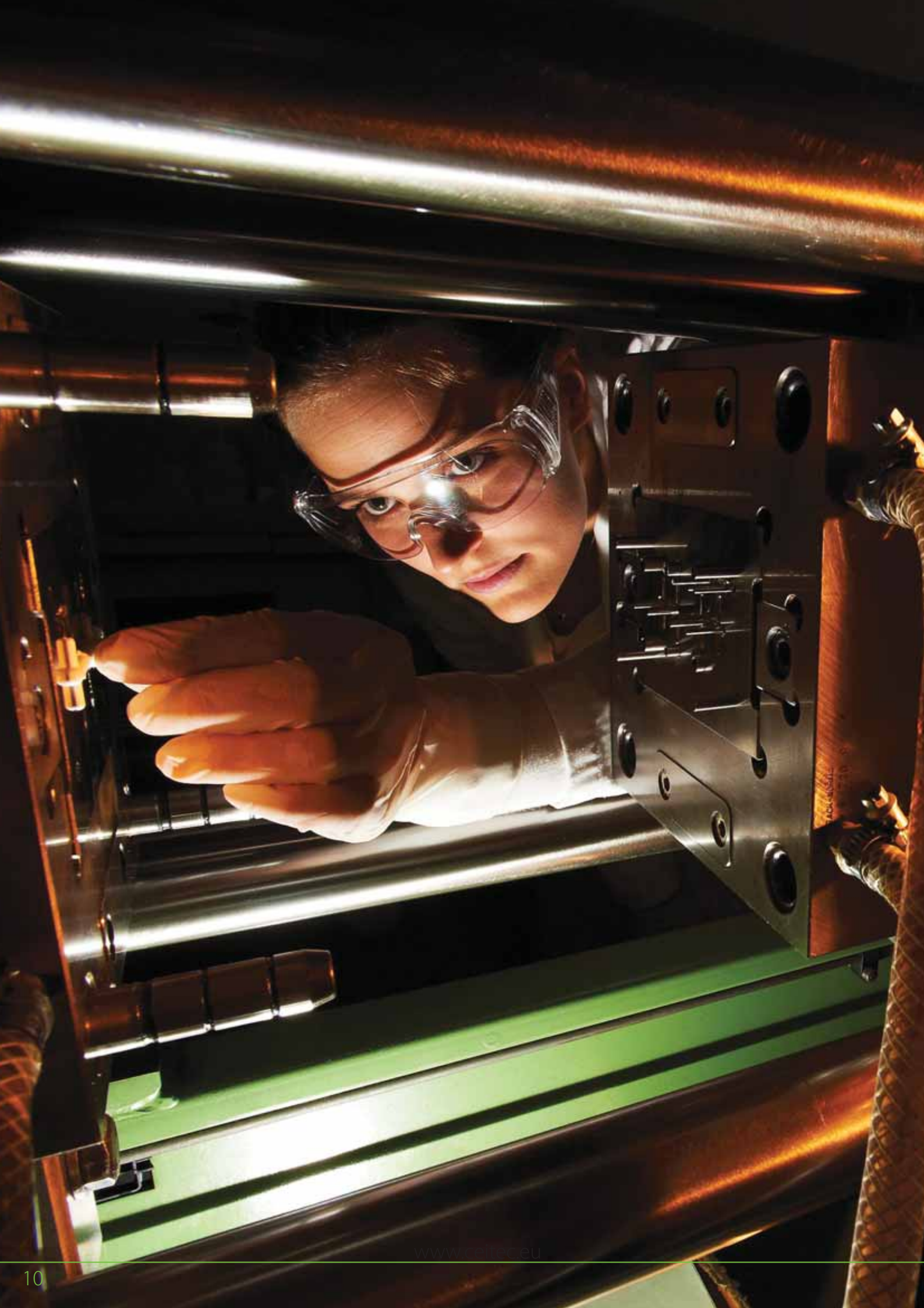
Brno University of Technology
www.vutbr.cz

Mendel University in Brno
www.mendelu.cz

University of Veterinary and Pharmaceutical Sciences Brno
www.vfu.cz

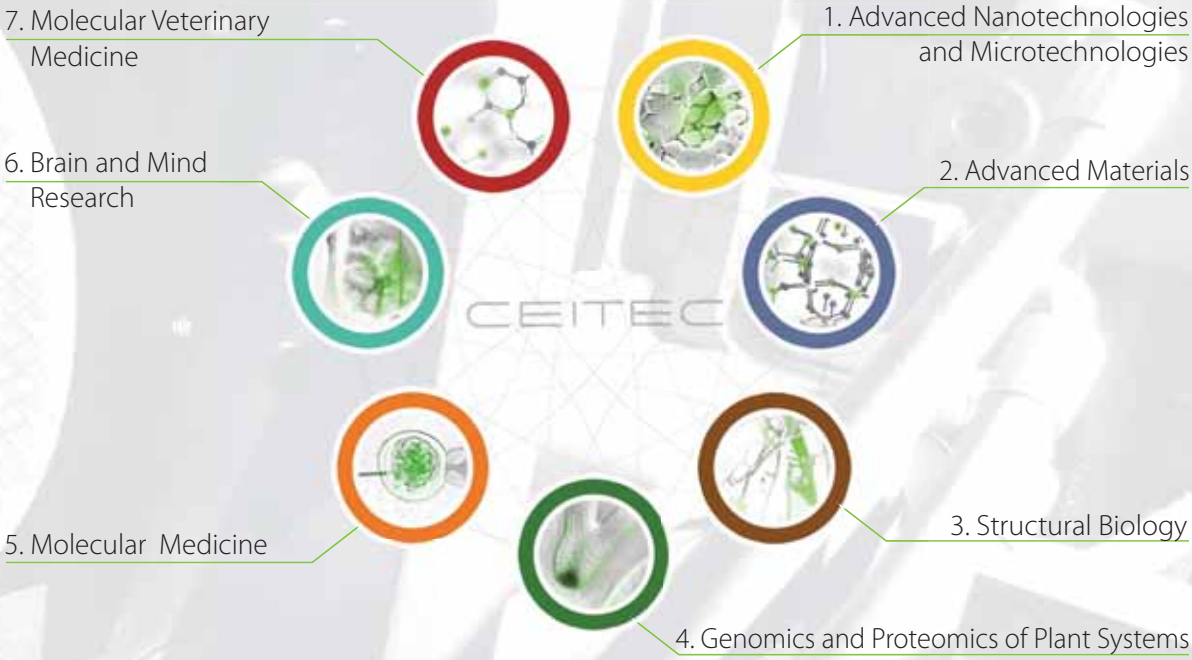
Institute of Physics of Materials, Academy of Sciences of the Czech Republic
www.ipm.cz

Veterinary Research Institute
www.vri.cz



Research Programmes

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

Coordinator: **Prof. RNDr. Tomáš Šikola, CSc.**

Characteristics of the Research Programme

The research is aimed at nanotechnologies covering materials and structures to be used in nanoelectronic and nanophotonic applications. The research comprises the preparation, characterisation and analysis of the properties of nanostructures enabling an active application of principles that determine the unique and specific properties of nanostructures. Attention will be focused on research of 2D-0D nanostructures produced by lithographic ('top-down') methods and self-organizing, ('bottom-up') methods. The research will consider semiconductor nanostructures, magnetic and metallic nanostructures, nanotubes and nanofibres, etc. The interconnection of nanostructures with peripheries and special micro-circuits will also be researched.

Overall Goal

The principal goal of this programme is to develop methods for the fabrication of nanostructures, to learn their unique properties and to utilise them in nanoelectronics and nanophotonics with respect to various relevant application outputs, including bio- and medical sensing and diagnostic methods and tools. The programme relies on the links and mutual cooperation among the research groups within the programme and beyond it, both in material/communication areas and life sciences. To meet this goal the shared clean-room laboratories equipped with complex planar technologies and state-of-the-art diagnostic techniques will be developed. Such facilities will be made available not only to research groups from CEITEC but also to external groups from academic institutions and industry. This will contribute to widening the cooperation on application subjects in the Czech Republic and the,Central European region. The laboratory will seek associate membership in ESFRI and collaborate with other centres at home and worldwide.

Research Directions

- Fabrication of nanostructures by 'bottom-up' methods
- Fabrication of nanostructures by 'top-down' methods (nanolithography)
- Investigation of functional properties of nanostructures
- Development of submicron devices and nanostructures
- Development of analytical and measurement methods

Research Groups | Research Group Leaders

RG-1-1 | Functional Properties of Nanostructures | **Josef Humlíček**
RG-1-2 | Submicron Systems and Nanodevices | **Jaromír Hubálek**
RG-1-3 | Experimental Biophotonics | **Radim Chmelík**
RG-1-4 | Fabrication and Characterisation of Nanostructures | **Tomáš Šikola**
RG-1-5 | Development of Methods for Analysis and Measuring | **Petr Klapetek**
RG-1-6 | X-ray Micro CT and Nano CT | **Jozef Kaiser**
RG-1-7 | Optoelectronic Characterisation of Nanostructures | **Lubomír Grmela**
RG-1-8 | Micro and Nanotribology | **Ivan Křupka**
RG-1-9 | Plasma Technologies | **Lenka Zajíčková**
RG-1-10 | Synthesis and Analysis of Nanostructures | **Jiří Pinkas**
RG-1-11 | Transport and Magnetic Properties | **Bohumil David**

Content of Research

WP-1-1 | Fabrication of nanostructures by 'bottom-up' methods
WP-1-2 | Development of nanostructures by 'top-down' methods (nanolithography)
WP-1-3 | Investigation of the functional properties of nanostructures
WP-1-4 | Research and development of submicron systems and nanodevices
WP-1-5 | Development of instruments and methods for the investigation of nanomaterials and nanostructures

2. Advanced Materials

Coordinator: **Prof. RNDr. Jaroslav Cihlář, CSc.**

Characteristics of the Research Programme

The research of advanced materials covers the synthesis of materials and the analysis of the structure and properties of advanced materials. The aim of the research is to develop novel materials with complex properties and propose novel application areas for these materials. The research is focused on advanced ceramic materials; advanced polymeric materials and composites; and advanced metallic materials.

Overall Goal

The overall goal is to establish an equipment and personnel infrastructure further enhancing excellence in the research of advanced (polymeric, ceramic, metallic and composite) materials and their applications in various industrial sectors, medicine and services. The main effort will be devoted to investigating advanced methods of preparing multifunctional homogeneous and heterogeneous advanced materials, characterising their structure on various dimensional scales; quantifying structure-property-function relationships on the various structural levels and developing procedures for engineering properties of this class of materials in the process of their preparation.

Research Directions

- Advanced ceramic materials
- Research and diagnostics of electrical properties of advanced materials
- Advanced polymers and composites
- Advanced metallic materials and metal-based composites
- Structure and phase analysis

Research Groups | Research Group Leaders

RG-2-1 | Advanced Ceramic Materials | **Jaroslav Cihlář**
RG-2-2 | Materials for Sensors and Technological Processes Control Systems | **Pavel Václavek**
RG-2-3 | Advanced Polymers and Composites | **Josef Jančář**
RG-2-4 | Advanced Metallic Materials and Metal Based Composites | **Ludvík Kunz**
RG-2-5 | Structure and Phase Analysis | **Jiří Švejcar**

Content of Research

WP-2-1 | Advanced ceramic materials
WP-2-2 | Materials for sensors and technological processes control systems
WP-2-3 | Advanced polymers and composites
WP-2-4 | Advanced metallic materials
WP-2-5 | Structure and phase analysis of advanced materials

3. Structural Biology

Coordinator: **Prof. RNDr. Vladimír Sklenář, DrSc.**

Characteristics of the Research Programme

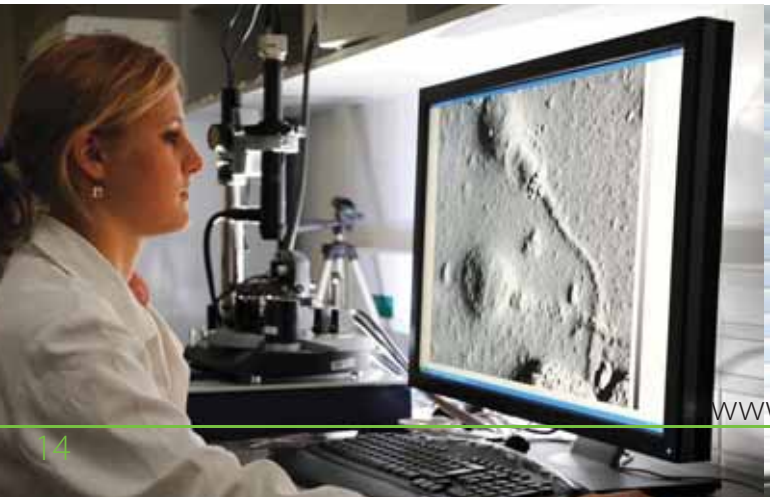
The research programme will integrate structural knowledge at different resolution levels into contexts of large macromolecular assemblies in order to gain understanding of vital processes at the cellular level. It aims to achieve European competitiveness, stimulate regional development, and facilitate biomedical research and biotechnologies.

Overall Goal

The research programme will integrate the three dimensional structural information describing large macromolecular assemblies - proteins, nucleic acids and their complexes - into functional contexts in order to gain an understanding of the vital processes at the cellular level. A variety of experimental techniques with a wide range of spatial resolutions; including single crystal X-ray diffraction; nuclear magnetic resonance; cryo-electron microscopy and tomography; and atomic force microscopy will be applied together with the methods providing an insight into the intermolecular interactions. Systematic in-vitro studies using a wide range of biophysical tools will be important for understanding the fundamental principles of molecular recognition. The experimental approach will be complemented by theoretical studies using tools of computational chemistry and bioinformatics. Time variations of three-dimensional structures, supplying essential information indispensable for painting a dynamic picture of key cellular functions will be investigated in detail. A new integrated infrastructure built within CEITEC will be used to develop modern methods of structural biology and to extract molecular data crucial for biochemical and biomedical applications. The research programme is aimed at achieving European competitiveness; stimulating regional development and facilitating biomedical research and biotechnologies. At the application level, its results will facilitate developments of next-generation diagnostic and therapeutic strategies for the treatment of human diseases and solutions of health problems.

Research Directions

- Investigation of the role of RNA in development and human diseases
- Therapeutic aspects of recognition and adhesion phenomena in host-pathogen interactions
- Visualisation and modification of biological objects including tissues, cells, cellular structures, and biomolecules
- Development of new methodologies for investigating the structure, interactions and dynamics of biomolecules
- High throughput structural characterisation of macromolecular assemblies by single crystal diffraction
- Establishing a high-end cryo-electron microscopy laboratory for highly sophisticated 3D imaging studies for structural biology at the cellular level



Research Groups | Research Group Leaders

RG-3-01 | Bioinformatics | **To be appointed**
RG-3-02 | CD Spectroscopy of Nucleic Acids and Proteins | **Michaela Vorlíčková**
RG-3-03 | CryoEM | **To be appointed**
RG-3-04 | Glycobiochemistry | **Michaela Wimmerová**
RG-3-05 | RNA Quality Control | **Štěpánka Vaňáčová**
RG-3-06 | Nanobiotechnology | **Petr Skládal**
RG-3-07 | Biomolecular NMR Spectroscopy | **Vladimír Sklenář**
RG-3-08 | NMR Spectroscopy II | **To be appointed**
RG-3-09 | NMR Spectroscopy III | **To be appointed**
RG-3-10 | Protein/RNA Interactions | **Richard Štefl**
RG-3-11 | X-ray Crystallography I | **Jaromír Marek**
RG-3-12 | X-ray Crystallography II | **To be appointed**
RG-3-13 | Structure and Dynamics of Nucleic Acids | **Jiří Šponer**
RG-3-14 | Structure and Interaction of Biomolecules at Surfaces | **Miroslav Fojta**
RG-3-15 | Computational Chemistry | **Jaroslav Koča**

Content of Research

WP-3-1 | Structural and molecular biology of RNA
WP-3-2 | Structural and molecular biology of host-pathogen interactions
WP-3-3 | Nanobiotechnology for health
WP-3-4 | New methods for structural biology
WP-3-5 | Protein crystallography
WP-3-6 | Gene expression profiling and sequence analysis
WP-3-7 | Cryo electron microscopy and tomography of cellular biopolymers
WP-3-8 | Biophysics and biophysical chemistry of biopolymers and their interactions

4. Genomics and Proteomics of Plant Systems

Coordinator: **Prof. RNDr. Jiří Fajkus, CSc.**

Characteristics of the Research Programme

The research programme is focussed on understanding evolution-based strategies of plant systems to promote their applications in next-generation technologies and medicine.

Overall Goal

Plants present a unique experimental system due to their enormous genome plasticity and the naturally totipotent character of their cells, which makes it possible to regenerate the whole organism from a single cell easily and without ethical problems. The developmental outcomes of molecular manipulations can thus be studied at the level of whole organisms.

Research Directions

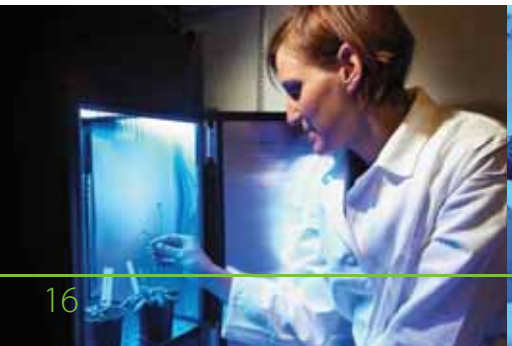
- Genome, karyotype and chromosome evolution; the role of repetitive DNA in genome dynamics; the structure, evolution and maintenance of telomeres and their role in chromosome stability and plant speciation; epigenetic regulations
- Molecular mechanisms governing hormonal regulations and their functions in plant development and stress-response; developmental outputs of subcellular protein trafficking and cell polarity will be established
- Metabolic profiling approaches for understanding and exploitation of plant secondary metabolites; using bacterial metabolomics as a model for systems biology; metabolite biomarkers for diagnostics; the development of a miniaturised drug metabolism system based on capillary electrophoresis (CE)
- To provide access to state-of-the-art technologies based on shared resources and highly trained staff in proteomics; the development of novel techniques for the separation and analysis of nucleic acids, proteins, small bioactive molecules & drugs and their complexes based on electrophoretic and microfluidic systems, electrochemical and optical methods and nanotechnologies

Research Groups | Research Group Leaders

RG-4-1 | Bioanalytical Instrumentation | **František Foret**
RG-4-2 | Plant Cytogenomics | **Martin A. Lysák**
RG-4-3 | Functional Genomics and Proteomics of Plants | **Jan Hejátko**
RG-4-4 | Hormonal Crosstalk in Plant Development | **Eva Benková (TBC)**
RG-4-5 | Metabolomics | **Zdeněk Glatz**
RG-4-6 | Core Facility - Proteomics | **Zbyněk Zdráhal**
RG-4-7 | Developmental and Cell Biology of Plants | **Jiří Friml (TBC)**
RG-4-8 | Chromatin Molecular Complexes | **Jiří Fajkus**
RG-4-9 | Developmental and Production Biology - Omics Approaches | **Břetislav Brzobohatý**

Content of Research

WP-4-1 | Comparative cytogenomics of plant families with contrasting genome structure
WP-4-2 | Structure, function and evolution of telomeres and their role in chromosome stability
WP-4-3 | Identification of the molecular factors and specific developmental processes underlying hormonal regulations in plants
WP-4-4 | Developmental role of subcellular dynamics and polarity of auxin transport components
WP-4-5 | Hormonal control of plant growth correlations and responses to environmental cues
WP-4-6 | Metabolomic tools used in the development of novel drugs; an analysis of plant secondary metabolism pathways as a source of novel bioactive compounds
WP-4-7 | New instrumental approaches to bioanalysis



5. Molecular Medicine

Coordinator: **Prof. RNDr. Šárka Pospíšilová, Ph.D.**

Characteristics of the Research Programme

The research programme plans to study the genetic background of important human diseases and to improve their diagnostics and therapy using application of modern genomic and molecular-biological technologies. The project also aims to bring novel findings into the pathogenesis of studied diseases and produce experimental strategies for their treatment and prevention. The main diseases studied will be cancer (both haematological malignancies and solid tumours); inherited diseases - mainly neuromuscular, neurodegenerative, metabolic and skin; digestive diseases; infectious diseases and immune defects.

Overall Goal

The main goals of this research programme are: (1) introduction of modern approaches of genome analysis; (2) the characterisation of cell behaviour on a molecular level, with the emphasis on malignant transformation, and resistance to modern anti-cancer treatment; (3) the analysis of the mechanisms leading to disturbances in immune response. New approaches for genome-wide analysis including comparative and functional genomics and proteomics will enable specific molecular diagnostics to be developed, and hopefully, the development of predictive and personalized medicine, and perhaps gene therapy.

Research Directions

- Mapping of key genetic defects in cancer cells; genomic and proteomic analyses of cancer cells in relation to therapy administration
- Development of user-oriented research focusing on improvement of current therapeutic protocols and experimental strategies to design novel therapeutic approaches
- Application of high-throughput analyses of the human genome in predictive oncology
- Molecular genetic diagnostics of selected neuromuscular, neurodegenerative, metabolic and skin disorders, application of high-throughput methods in analysis of the human genome
- Study of mechanisms leading to disturbances in immune response with an emphasis on quantitative and qualitative defects (primary and secondary immune deficiency, allergy, allergooncology, autoimmunity); analysis of genes involved in immune response
- Characterisation of genetic determinants of host-pathogen interactions; development of novel diagnostic strategies in human infections
- Application of new DNA sequencing strategies to analyse complex biological samples including small, environmental and experimental DNA samples
- Regulation of eukaryotic transcription, role of P-TEFb and other CTD kinases in the regulation of transcriptional elongation, transcriptional cyclin-dependent kinases and their role in human disease

Research Groups | Research Group Leaders

RG-5-1	Medical Genomics	**Šárka Pospíšilová**
RG-5-2	Molecular Oncology I - Hematooncology	**Martin Trbušek**
RG-5-3	Molecular Oncology II - Solid Cancer	**Ondřej Slabý**
RG-5-4	Inherited Diseases I - Genetic Research	**Lenka Fajkusová**
RG-5-5	Inherited Diseases II - Transcriptional Regulation	**Dalibor Blažek**
RG-5-6	Molecular Immunology and Microbiology	**Tomáš Freiberger**
RG-5-7	Molecular Gastroenterology and Hepatology	**Pavel Strnad**
RG-5-8	Genome Dynamics	**Eduard Kejnovský**
RG-5-9	Core Facility - Genomics	**Boris Tichý**

Content of Research

WP-5-1	Application of genomic approaches in cancer research and diagnostics
WP-5-2	Development of novel therapeutic strategies for the high-risk cancer patients
WP-5-3	Significance of microRNA in pathogenesis, diagnosis and therapy of colorectal and renal carcinomas and glioblastoma multiforme
WP-5-4	Genetics of inherited disorders
WP-5-5	Regulation of eukaryotic transcription
WP-5-6	Molecular immunology and microbiology
WP-5-7	Animal model as a tool towards the understanding of digestive disorders
WP-5-8	Role of genome dynamics in human diseases
WP-5-9	Genomics Core Facility

6. Brain and Mind Research

Coordinator: **Prof. MUDr. Milan Brázdil, Ph.D.**

Characteristics of the Research Programme

The research programme is dedicated to understanding how the nervous system works at different levels - from molecular and cellular to system; from basic structure and physiology to complex behaviour, including human emotional, cognitive, and social functions; from health to disease.

Overall Goal

To promote a collaborative theoretical, experimental, and clinical study of the brain from the molecular to the behavioural and cognitive levels. In addition, extensive research will be performed on cellular, molecular, and clinical aspects of damage and reparation of neural tissue and selected brain disorders (e.g. schizophrenia, cerebellar disorders, etc). Interdisciplinary research will be completed in the fields of neurobiology, neuropsychopharmacology, functional neuroanatomy, neurophysiology, neuroimaging, neuropsychology, neurology, psychiatry, and computational neuroscience. Advanced biomedical imaging methods currently start to cross the previously unreachable boundary of the microscopic and molecular level and their applications can substantially contribute to better understanding of the physiological and pathological changes in the nervous system, the multi-level study of animal and human behaviour, and translational research with a strong impact on the management of neuropsychiatric diseases.

Research Directions

- Development of new biomedical imaging methods and their translation into clinical neuroscience
- Cellular and molecular neurobiology of nerve regeneration and neuropathic pain induction. Studies dedicated to the neuropsychology-pharmacology-molecular biology interface
- Multimodal approach to the advanced study of cognitive and behavioural functions

Research Groups | Research Group Leaders

RG-6-1 | Cellular and Molecular Neurobiology | **Petr Dubový**
RG-6-2 | Molecular and Functional Neuroimaging | **Ivan Rektor**
RG-6-3 | Experimental and Applied Neuropsychopharmacology | **Alexandra Šulcová**
RG-6-4 | Psychophysiology | **Miloslav Kukleta**
RG-6-5 | Behavioural and Social Neuroscience | **Milan Brázdil**
RG-6-6 | Applied Neuroscience | **Irena Rektorová**

Content of Research

WP-6-1 | Cellular and molecular neurobiology of nerve regeneration and neuropathic pain induction
WP-6-2 | Principles in neural connectivity underlying normal and pathological brain processing
WP-6-3 | Genetics and epigenetics of neuropsychiatric diseases
WP-6-4 | Mechanisms of CNS adaptation on pathological factors and therapy
WP-6-5 | MR technology for high-field MR imaging and spectroscopy


7. Molecular Veterinary Medicine

Coordinator: **Prof. RNDr. MVDr. Petr Hořín, CSc.**

Characteristics of the Research Programme

Important biological processes and diseases will be studied in selected animal models. Complex mechanisms of resistance to infectious diseases and of mammalian reproduction will be analyzed by using various methodological approaches, including host and pathogen genomics and proteomics. Based on this knowledge, potential practical applications will be investigated, like prevention of circulation of important pathogens in the food chain and/or biotechnological potential of specific animal models of mammalian reproduction.

Overall Goal

Immunity and reproduction are the most important traits related to survival. Infectious diseases of animals have a significant economic impact and represent an environmental risk. This programme should promote the development of complex multidisciplinary approaches to study these basic biological processes and their potential applications in diagnostics, therapy, prevention and public health. Therefore, molecular and cellular mechanisms underlying host and pathogen interactions and mammalian reproduction will be studied. In the field of infectious diseases, pathogens causing important infections, including major foodborne pathogens and emerging pathogens at the human-domestic animal-wildlife interface will be studied in the context of host genetic mechanisms of disease. Possible applications, based on molecular techniques and on improvements in nanotechnologies and gene therapy, will be investigated. In the field of reproduction, chromosomes in somatic and germ-line cells, their evolution and role in reproduction will be analyzed. Mechanisms controlling acquisition of meiotic competence during oocyte growth and aging oocytes will be studied on animal models. Genomic, proteomic and bioinformatic approaches, cell culture, single cell techniques, live cell imaging, and biosensors will be used.

Research Directions

- Analysis of causes, mechanisms and spread of infectious diseases in domestic animals
- Analysis and prevention of circulation of zoonotic pathogens in the food chain
- Host genomics and genetics in infections and reproduction
- Animal models of mammalian reproduction and their biotechnological potential

Research Groups | Research Group Leaders

RG-7-1 | Molecular Virology | **Vladimír Celer**
RG-7-2 | Molecular Bacteriology | **Alois Čížek**
RG-7-3 | Parasitology | **Břetislav Koudela**
RG-7-4 | Food Safety | **Iva Steinhauserová**
RG-7-5 | Orthopaedics and Surgery | **Alois Nečas**
RG-7-6 | Animal Imunogenomics | **Petr Hořín**
RG-7-7 | Animal Cytogenomics | **Jiří Rubeš**
RG-7-8 | Mammalian Reproduction | **Martin Anger**

Content of Research

WP-7-1 | Analysis of the causes, mechanisms and spread of infectious diseases in domestic animals
WP-7-2 | Analysis and prevention of the circulation of zoonotic pathogens in the food chain
WP-7-3 | Host genetics and comparative immugenomics of the family Equidae
WP-7-4 | Comparative cytogenomics and the genetics of reproduction
WP-7-5 | Animal models of mammalian reproduction

Core Facilities

The Core Facilities (central laboratories), which will serve as main features of integration, 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 CEITEC Science Park.

CEITEC is successfully networking with other research infrastructures across Europe. In June 2011, *The Structural Biology* Core Facilities were approved as a National Affiliated Centre of INSTRUCT. We are also actively participating in other European infrastructure projects such as Euro-BioImaging (biological and biomedical imaging) and ELIXIR (bioinformatics).

1. Nanolithography and Nanofabrication

Head: **Prof. RNDr. Tomáš Šikola, CSc.**

Main Activity

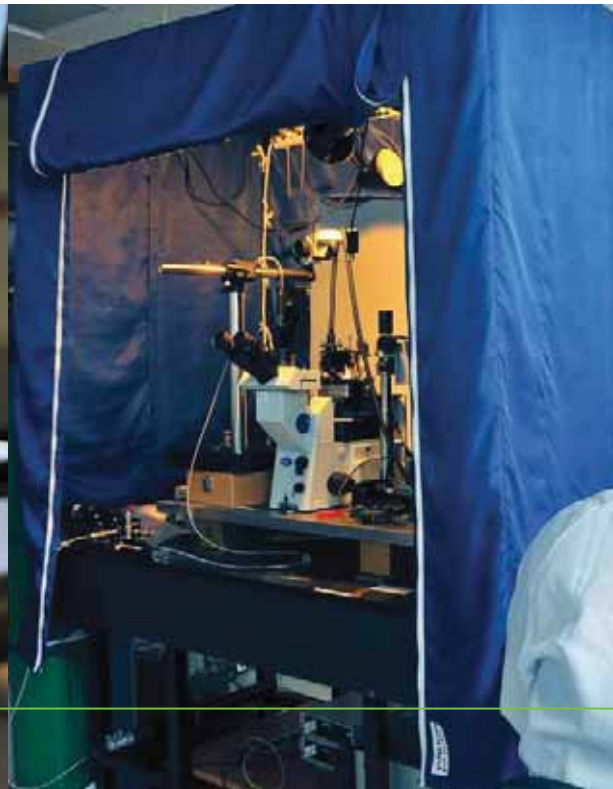
Fabrication of nanostructures by lithographic methods ('top-down' approach) and by self-assembly methods ('bottom -up' approach). All necessary technological steps for the fabrication of functional nanodevices (design, lithography, metallization, sputtering, packaging, testing) will be available to the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

Unique Features

Clean room laboratory (class 100 – 1 000) equipped with state-of-the-art techniques for the nanofabrication of nanostructures allows 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 enabling both the fabrication of complex functional nanostructures and nanodevices and provides their diagnostics.

Key Equipment (Core Facility fully operational from 2014)

- E-beam lithography system
- UV maskless lithography system
- DUV mask aligner with nanoimprint lithography option
- Automatic coating and developing system
- Wet benches for manual coating and developing
- Microscope
- Reflectometer
- Mechanical profilometer
- LPCVD & PECVD
- MOCVD (MOVPE)
- Wet benches for chemical processes
- RIE resist stripper
- DRIE in r.f. ICP (fluorine)
- RIE in r.f. ICP (chlorine)
- IBE, RIBE, IBS, IBAD incl. mass spectrometer
- MBE
- ALD
- PECVD + RIE, 400°C, movable electrode
- PECVD - ICP, 400°C
- E-beam evaporator
- Magnetron sputtering system, 2 chambers 6DC 4RF magnetrons
- Wafer wire bonding and contacting
- Laser trimming/dicing of Si and ceramic substrates
- Testing environmental chamber
- Probe station
- Licences of COVENTOR software for MEMS design
- Licences of CADENCE software for design and simulation of integrated circuits



2. Nanocharacterisation

Head: **Prof. RNDr. Josef Humlíček, CSc.**

Main Activity

Characterisation of surfaces and nanostructures by various analytical methods. Also includes complex facilities for in-situ investigation of the processes responsible for the growth of thin films and self-assembling nanostructures.

Unique Features

Clean room laboratory (class 1 000 – 100 000) equipped with state-of-the-art techniques for characterisation of nanostructures allows effective control and analysis of all types of nano- and microstructures and devices. Together with *the Nanolitography and Nanofabrication* Core Facility, it offers a unique combination of techniques enabling both the fabrication of complex functional nanostructures and nanodevices and provides for their diagnostics.

Key Equipment (Core Facility fully operational from 2014)

- XPS
- SIMS
- SEM
- SNOM
- TERS + Micro-Raman
- Vacuum FTIR
- NIR/VIS/UV/(VUV) spectrometers and ellipsometers
- Powder XRD diffractometer
- Low temperature (He) electrical and magnetic transport measurement system
- Semiconductor characterisation system
- Electronic measurement components
- Complex UHV equipment for in-situ deposition and in-situ analysis (MBE, STM, nano-SAM)
- PLD deposition system: UHV, in-situ RHEED, IR laser rating
- Experimental PECVD system
- Scanning electron microscope with focused ion beam and 4 nanomanipulators
- Scanning probe microscopy for fabrication of nanostructures

3. Structural Analysis Laboratory

Head: **Prof. Ing. Jiří Švejcar, CSc.**

Main Activity

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. Precise manufacturing of TEM foils by ion beam.

Unique Features

Highly advanced materials imaging at the atomic scale level will be available to all CEITEC research groups, 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. Instrumental capacity will be shared mainly inside CEITEC and partially offered outside.

Key Equipment (Core Facility fully operational from 2014)

- High resolution (sub nanometer) FEG SEM + analytical attachments (EDS + WDS + EBSD)
- High resolution 300 keV FEG TEM/STEM with aberration correctors + analytical systems (EDS + EELS)
- TEM and SEM sample preparation unit (ion polisher for TEM foils, ion polisher for bulk SEM specimens and electrolytical polisher for TEM foils)
- FEG -SEM high/low vacuum + analytical attachments (EDS + WDS + EBSD)
- XRD + Goebble mirror for HR spectra acquisition + JCPDS database + high temperature chamber

4. Nanobiotechnology and Biointeractions

Head: **Doc. RNDr. Petr Skládal, CSc.**

Main Activity

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.

Unique Features

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.

Key Equipment (Core Facility fully operational from 2014)

- Combined AFM / inverted optical microscopes
- SPR biosensors
- AFM microscopy systems for nanobiointeractios
- Isothermal titration calorimeter
- Multichannel SPR system

5. Single Crystal X-ray Diffraction

Head: **Doc. RNDr. Jaromír Marek, Ph.D.**

Main Activity

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 10^2 up to 10^6, where the lower value covers molecules significant for nanotechnology, material science or pharmacology and upper limit covers biomacromolecules such nucleic acids, proteins and their complexes. Automated screening of crystallisation conditions, optimisation of protein crystals growth.

Unique Features

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.

Key Equipment (Core Facility fully operational from 2014)

- Macromolecular single crystal diffraction system
- Universal chemical and protein diffractometer and X-ray and optical protein scanner
- Automated crystallisation laboratory - liquid handling
- Automated crystallisation laboratory - sample storage and inspection

6. High-field NMR Spectroscopy

Head: **Prof. RNDr. Vladimír Sklenář, DrSc.**

Main Activity

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).

Unique Features

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. External user projects will be selected by peer review on the basis of scientific merit, technical suitability and feasibility. The centre will also offer training enabling non-specialists to develop the necessary skills.

Key Equipment (Core Facility fully operational from 2012)

- 950 MHz NMR spectrometer for high-resolution spectroscopy in liquids
- 850 MHz NMR spectrometer for high-resolution spectroscopy in liquids
- 700 MHz NMR spectrometer for high-resolution spectroscopy in liquids
- 700 MHz NMR spectrometer for high-resolution spectroscopy in liquids and solids
- 600 MHz NMR spectrometer for high-resolution spectroscopy in liquids
- 500 MHz NMR spectrometer for high-resolution spectroscopy in liquids and solids

7. Cryo-electron Microscopy and Tomography

Head: **To be appointed**

Main Activity

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.

Unique Features

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. The centre will also offer training enabling non-specialists to develop the necessary skills. The high-end instrumentation and the team of experienced researchers will ensure expert services, user training and the cost-effective use of resources.

Key Equipment (Core Facility fully operational from 2014)

- Transmission high-throughput cryo-electron microscope 300 kV
- Transmission cryo-electron microscope 200 kV
- Equipment for sample preparation
- Vitrification robot

8. Proteomics

Head: **Doc. RNDr. Zbyněk Zdráhal, Dr.**

Main Activity

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 bioinformatic data processing.

Unique Features

The Core Facility provides academic community and other subjects with access to advanced proteomic technologies based on shared resources and highly trained staff. The concentration of expensive instrumentation and know-how results in fast responses to the demands of the research community and the effective utilization of resources.

Key Equipment (Core Facility fully operational from 2014)

- High-resolution mass spectrometer (FTMS)
- Hybrid mass spectrometer (e.g. Q-LIT)
- MALDI-TOF/TOF mass spectrometer

9. Genomics

Head: **MVDr. Boris Tichý, Ph.D.**

Main Activity

Application of new high-throughput methods into basic and applied research. Development and optimisation of methods for genomic analyses.

Unique Features

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, micro-dissection) 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.

Key Equipment (Core Facility fully operational from 2014)

- High-throughput massive parallel sequencers
- FACS cell sorter
- Cell analysis system
- Real-time microfluidic qPCR
- Microarray systems

10. Molecular and Functional Imaging

Head: **Prof. MUDr. Ivan Rektor, CSc.**

Main Activity

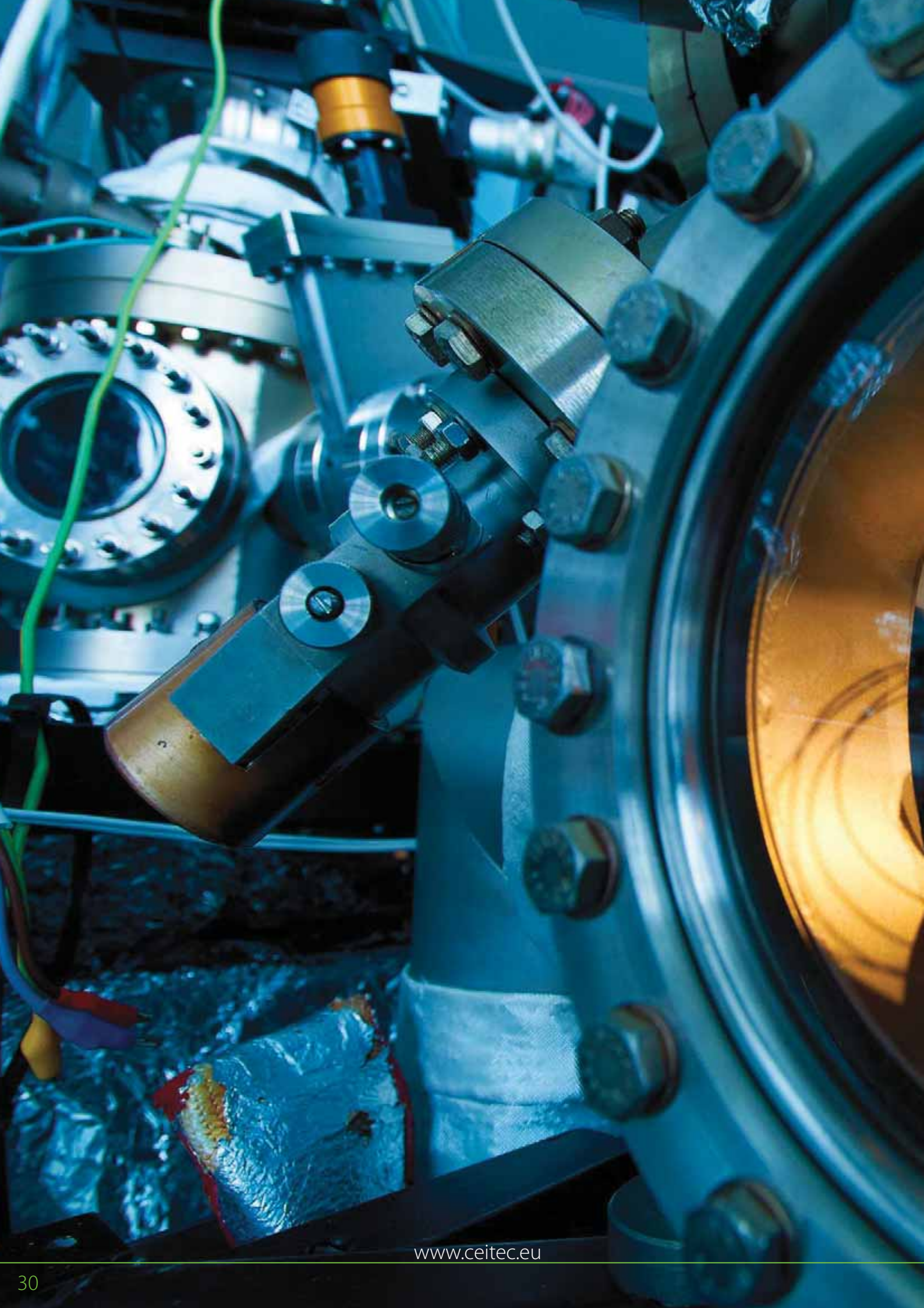
Methodologies for in-vivo magnetic resonance imaging (MRI) and magnetic resonance spectroscopy (MRS) of human, animal and plant tissues with spatial resolution reaching to 0.1 mm, with the main application in functional (fMRI) and molecular imaging (mMRI) of the brain.

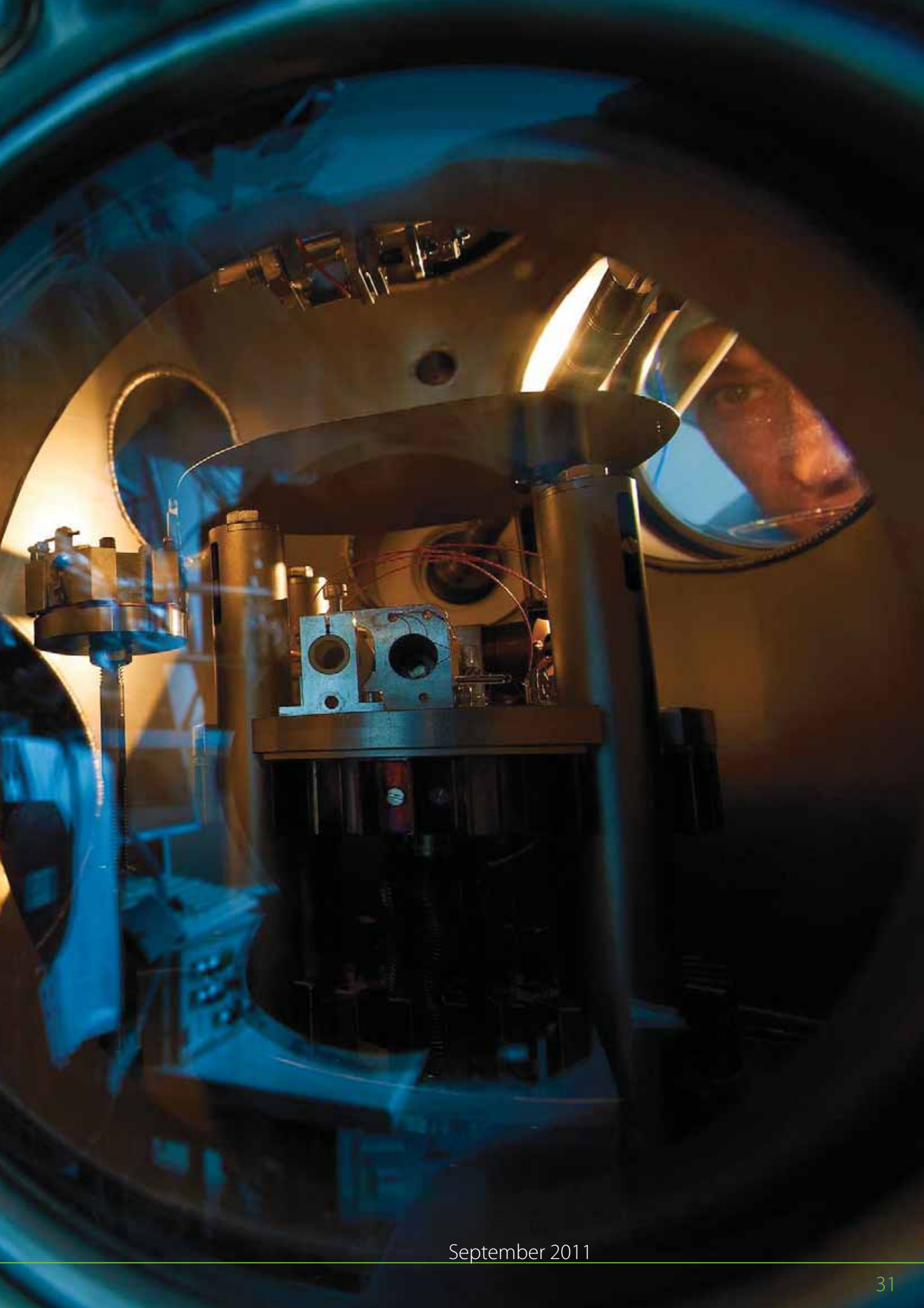
Unique Features

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.

Key Equipment (Core Facility fully operational from 2014)

- Head human 7T MR scanner
- Whole-body human 3T MR scanner
- Multichannel head RF coil for 7T MR
- MR compatible EEG system
- MR compatible stimulation system





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