The Czech Academy of Sciences 2015−2016

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THE CZECH ACADEMY OF SCIENCES

ADDRESS OF THE CAS PRESIDENT JIŘÍ DRAHOŠ



The CAS President Prof. Jiří Drahoš.
Photo: Stanislava Kyselová

Throughout the whole of 2015, the Czech Academy of Sciences continued to implement its long-term strategy aimed at the further and vigorous development of its research, educational and cultural activities. Among significant social events highlighted by the CAS during the whole of the year, prominence was given to the celebrations of the 125th anniversary of the foundation of ´The Czech Academy of Emperor Franz Josef I for Sciences, Literature and Art´ (ČAVU), which – together with other scientific institutions – formed the basis of the Czechoslovak Academy of Sciences established in 1952. Notwithstanding the fact that the idea of establishing a non-university research institution in the Czech Lands is much older, the year 1890 represents one of the milestones on the long road leading to the formation of modern Czech science. On January 23rd of that year, the Emperor confirmed the prestigious status of the Czech educated elite that had long exerted every effort to establish a national research institution – an Academy of Sciences.

20 years later the potential shape of the Czech Academy was outlined by T. G. Masaryk in the *Athenaeum* journal. When considering its future profile, he envisioned an institution whose publication and auxiliary activities would encourage universities to meet their pedagogical and scientific objectives. Masaryk´s concept was not put into practice at that time, nevertheless the succeeding architects and organizers of the Czech Academy could both find inspiration in his ideas and the challenge of implementing them.

It is, therefore, no coincidence that at present, 125 years later, the CAS considers its participation in education to be an integral part of its mission, rated just next to research in significance. To function as a scientific research institution, the Czech Academy of Sciences must, therefore, be engaged in education as well. And vice versa: to serve as educational institutions, universities must also inevitably act as scientific research institutions.

It should be emphasised, on the other hand, that in spite of their close connection with the process of education, the Institutes of the CAS, unlike universities, are obliged, and have all the necessary prerequisites, to focus primarily on addressing highly specialized or extensive interdisciplinary projects requiring long-term concentrations of capacities as well as expensive infrastructure.

It is my pleasure to point out, therefore, that in 2015 we succeeded in launching our new *Strategy AV21*, within the framework of which the CAS can perform research into complex and pressing issues facing contemporary society, including future energy resources in the Czech Republic, human health, migration, and effective public policies, the solution of which requires broad-based multilateral interdisciplinary research. That is why I consider the year 2015 as a significant milestone in the existence of the CAS. I am convinced that the novel mission of our Academy is best expressed in its new motto: *Top Research in the Public Interest*.

THE CZECH ACADEMY OF SCIENCES IN 2015:

FACTS AND FIGURES

As a public non-university research institution comprising a system of scientific institutes, the Czech Academy of Sciences conducts research in a broad range of sciences and humanities: from mathematics and physics through technical, chemical, biological, medical and Earth sciences to history, philosophy, linguistics and art. At the same time it lays great emphasis on promoting the transfer of new scientific findings and newly-developed technologies into practical use. The CAS also considers as its major role its contribution to the advancement of knowledge and education and to the popularization of scientific achievements.

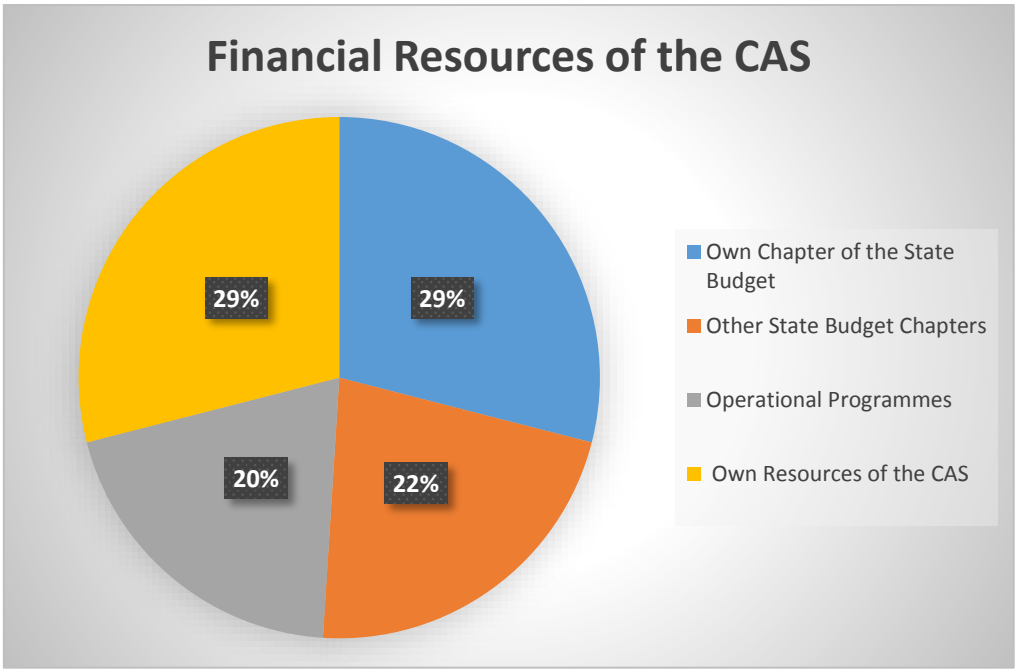
Evaluation of the CAS, Management, Projects, Employees
In 2015 the CAS concluded the evaluation of the research and expert activities of its 54 Institutes for the period 2010–2014, the aim of which was to acquire detailed information for its strategic management, including qualitative and quantitative data assessing the CAS position in the national, European and worldwide context over the given period as well as to provide independent evaluation and feedback necessary for the management of the individual Institutes and their research teams.

In the first phase, the performance of 377 scientific teams from 52 Research Institutes was assessed by over 1,200 experts from fifty countries and 24 from the Czech Republic. 16.5% of the total number of 5,594 assessed outputs were classified as “world-leading”, almost 42% of the outputs were declared “internationally excellent”. Another 35% were described as “recognized internationally“, six per cent as “recognized nationally” and 0.4% of the outputs were assigned to be non-scientific, below standard or uncategorized.

In the second phase the assessment was completed with the evaluation of the CAS Institutes and their teams from the point of view of the overall quality of their outcomes, including their societal, economic and cultural benefit, their position in the international and national context, the engagement of students in the research, the sustainability and the prospects as well as research plans for the coming period. Two infrastructure Institutes – The Centre for Administration and Operations of the CAS and The Library of the CAS – were evaluated independently on the basis of a different methodology.

In 2015, the CAS and its Institutes managed a total of 16,035 million CZK of which 29% came from its own chapter of the state budget. 22% of CAS financial resources were received from other state budget chapters in the form of targeted funding of 1,740 specific research projects; a further 20% came from Operational programmes co-financed with EU structural funds – in 2015 the Institutes participated in implementing 78 such projects – and 29% of the total CAS resources stemmed from its own economic activities, including the sale of licenses, publications and services etc.

The total number of employees (given as an average number of employees expressed in Full Time Equivalent – FTE) of the CAS reached 8,613 in 2015, out of which 5,040 were researchers of the required certification. The average monthly income of the employees amounted to 36,884 CZK, which is a 2% increase compared with 2014.


Financial Resources of the CAS
29%
29%
20%
22%
Own Chapter of the State Budget
Other State Budget Chapters
Operational Programmes
Own Resources of the CAS

SELECTED RESEARCH RESULTS

The Czech Academy of Sciences consists of 54 Public Research Institutes divided into three research areas: the first includes mathematics, physics and Earth sciences, the second one covers life and chemical sciences and the third deals with humanities and social sciences.

I. Mathematics, Physics and Earth Sciences

Mathematics, Physics and Computer Science

Astronomical Institute
Institute of Physics
Institute of Mathematics
Institute of Computer Science
Nuclear Physics Institute
Institute of Information Theory and Automation

In 2015, the six Research Institutes devoted to this field of science acquired new significant theoretical findings, for example concerning the behaviour of both matter and anti-matter, X-ray polarization fluctuations in active galactic nuclei as well as about plasma turbulence and kinetic instabilities in the expanding solar wind. New methods were presented substantially advancing the capabilities of atomic force microscopes to image chemical structures of single molecules deposited on surfaces at ambient temperature. Exotic states of magnetic materials were studied; researchers made progress in studying scintillation materials and other types of nano/materials with special characteristics to be applied in medicine, numerous production processes as well as in nuclear reactors; attention was also focused on advanced random field methods in data assimilation for short-term weather predictions.

The Institute of Physics introduced a simple approach to synthesize stable, high pressure high temperature nanodiamonds of excellent purity and crystallinity that are as small as 1.1 nm. Nanodiamonds of such a minute size have been artificially prepared for the first time. Scientists expect they will soon be able to study quantum phenomena in diamonds, which will allow their broader use in biomedicine and spintronics.

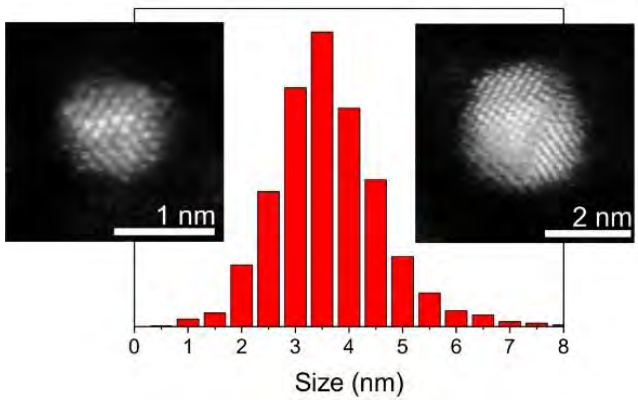
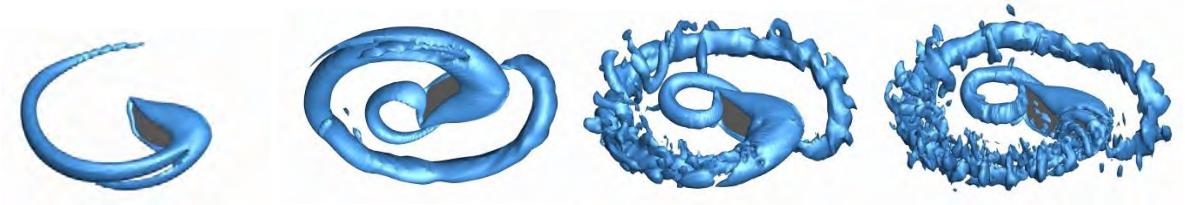


Figure: The Institute of Physics of the CAS

The Institute of Mathematics provided new highly-resolved computations of airflow around a rotating insect wing, examined its vortex structure and aerodynamic loading for different velocities. The simulations helped determine aerodynamic characteristics that otherwise could not be identified experimentally**.**

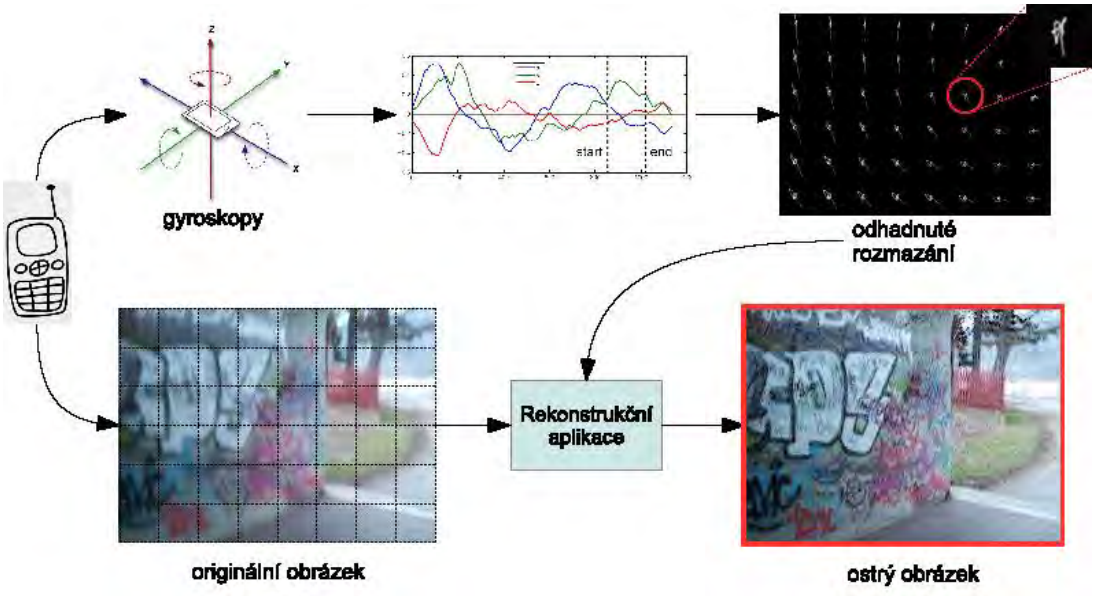


Vortical structures behind the rotating wing of a fruit fly at four different velocities.
Figure: The Institute of Mathematics of the CAS

A set of mathematical and computer methods was developed in ***The Institute of Computer Science*** to identify causal connections in complex spatio-temporal systems to explain, for instance, how changes in temperature, precipitations and wind in one region of the Earth are connected with similar changes on other, distant places. This can help assess risks brought about by climate change, the impact of geoengineering constructions on the environment or the global consequences of local weather extremes.

The application of nuclear analytical methods and other approaches allowed experts in ***The Nuclear Physics Institute*** to suggest a new location of the crater of origin of Asian-Australian tektites or impact glasses.

The Institute of Information Theory and Automation addressed one of the key problems of image processing: removing blur from digital images without any knowledge of the blur form. A probabilistic method was developed within *The Image Blind Deconvolution in Demanding Conditions Project* that removes blur even in situations with discrepancies in the mathematical model. Tests in different fields were conducted, such as in photography, astronomy, ophthalmology or nuclear medicine. An experimental implementation of image deblurring was tested even in mobile phones.





Examples of Deblurring: Original pictures (left) and pictures with removed blur (right).
Figure: The Institute of Information Theory and Automation of the CAS

Applied Physics

Institute of Photonics and Electronics
Institute of Physics of Materials
Institute of Plasma Physics
Institute of Hydrodynamics
Institute of Scientific Instruments
Institute of Theoretical and Applied Mechanics
Institute of Thermomechanics

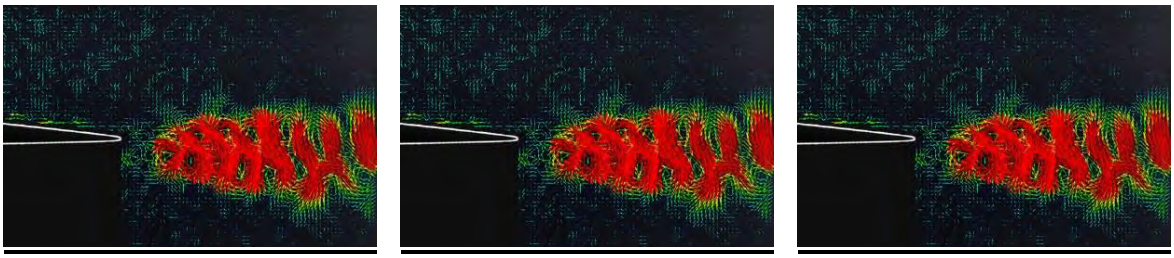
Last year´s research conducted by the seven Institutes of the CAS and covering various fields of applied physics resulted in the enhancement of highly sensitive biosensors for the detection of chemical and biological substances, the introduction of novel diagnostic methods and medical instruments to be used in clinical practice, including a non-invasive apparatus determining the state of the cardiovascular system. Relationships between the behaviour and properties of materials and their structural and microstructural characteristics, between various design parameters and overall mechanical properties were investigated and established. Scientists continued in detailed characterizations of thermal effects in wind tunnel simulations of the atmospheric boundary layer flow developing above complex terrain formations and research also focused on numerous topics related to plasma and so on.

The Institute of Scientific Instruments evolved algorithms for detecting life-threatening heart arrhythmias and was placed first and second in two categories of The Computing in Cardiology/Physionet Challenge awards.

The Institute of Photonics and Electronics made progress in understanding the mechanisms controlling ultra-weak photon emissions or "biophotons" emitted by biological systems as a result of oxidative metabolism and stress and developed methods for their detection and measuring. Since excessive oxidative processes are often connected with serious diseases,

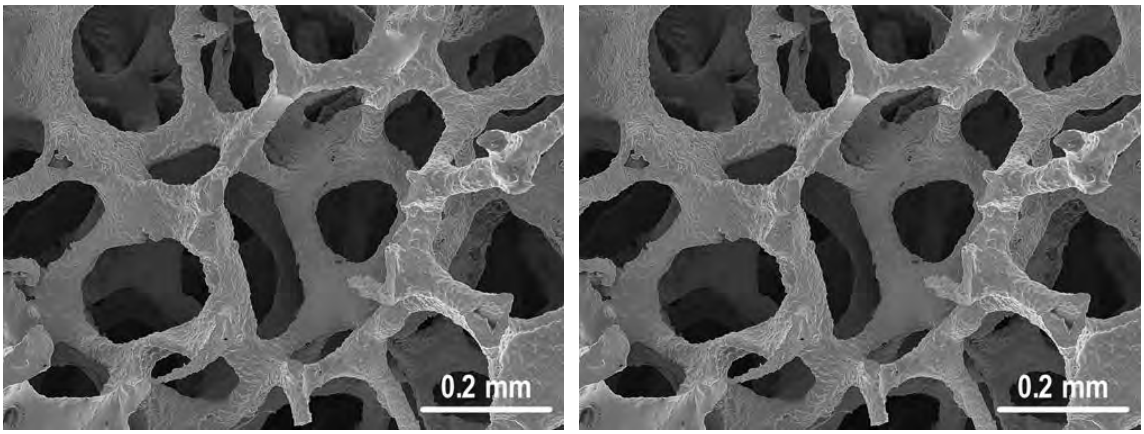
including cancer, the analysis of these biosignals can potentially serve as a rapid and non-invasive method for diagnosing oxidative stress in biology and medicine.

Using its own Oscillation Pattern Decomposition method, ***The Institute of Thermomechanics*** explored complex spatial dynamics of the flows around a steady and vibrating airfoil and succeeded in finding almost periodical patterns in vortex structures, the parameters of which depend on the type of flow around the airfoil as well as its motion. The detailed examination of such structures contributes to explaining the origin of the lift.



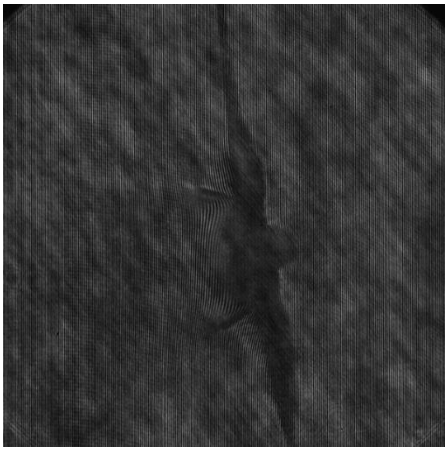
Examples of vortex structures topology; the vortex street parameters are a function of the type of flow around the airfoil as well as its motion.
Figure: The Institute of Thermomechanics of the CAS

New ways of testing and increasing the fracture strength and crack resistance of materials based on biocompatible glass, potentially applicable as bone replacements, were introduced at ***The Institute of Physics of Materials*** with the aim of reducing the intrinsic brittleness of bioactive glasses. Researchers helped improve mechanical properties of glass-based porous "scaffold" by depositing a novel thin polyvinyl-alcohol/microfibrillated cellulose composite coating. Coated samples exhibited remarkably higher tensile strength than non-coated ones.



The structure of porous bioglass with composite coating (left).
A detail of the coating with microfibres (right).
Photo: The Institute of Physics of Materials of the CAS

Physicists at the *PALS* laser facility, which is a joint laboratory of ***The Institute of Plasma Physics*** and ***The Institute of Physics***, have for the first time ever accelerated protons in hot plasma produced by a laser from hydrogen which was frozen into a solid state at temperatures as low as minus 261°C. By focusing a high-power laser beam onto a pure hydrogen ice target, hot hydrogen plasma was produced and its protons accelerated very efficiently to high energies. High-energy protons find applications in medicine for the irradiation of tumours as well as in many other scientific and technological fields, including proton radiography.



The PALS laser facility was the first in the world to produce plasma by focusing a high-power laser beam onto a pure hydrogen ice target – as showed by the interferogram.
Figure: The Institute of Plasma Physics of the CAS

Researchers at ***The Institute of Hydrodynamics*** have shown that organic matter produced by blooms of algae and cyanobacteria considerably affects the performance of water treatment plants. It interferes with all water treatment processes, increases coagulant demand, blocks filter membranes etc., thus affecting the resulting water quality. Researchers have clarified interaction mechanisms between algal organic matter and coagulants used in water treatment, which allows the improvement of the existing technologies in order to ensure high-quality drinking water even in the case of the massive proliferation of phytoplankton.

Earth Sciences

Institute of Geophysics
Institute of Geology
Institute of Atmospheric Physics
Institute of Geonics
Institute of Rock Structure and Mechanics

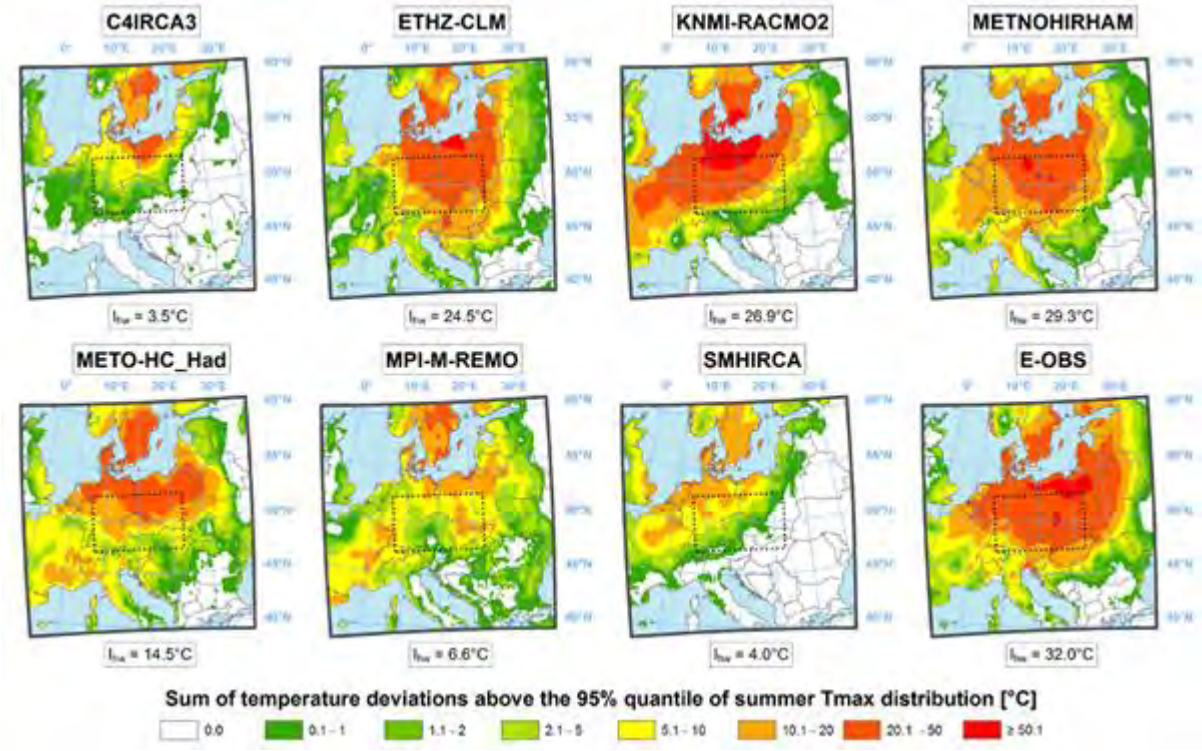
Research carried out in 2015 into numerous global, continental and regional processes in the atmosphere, hydrosphere and inside the crust and lithosphere of our planet Earth from the geological, geophysical, geochemical and hydrological points of view has enriched the overall knowledge of temperature conditions on the interface between the air and the Earth´s surface. It had also highlighted geophysical anomalies at specific locations, and also the origin and evolution of minerals and rocks at one of the largest volcanic complexes in Europe. Progress was achieved in the study of geomaterials and their interaction with the environment, the microstructure and the micromechanical properties of geopolymer composites as well as in the development of construction and biocompatible materials.

The Institute of Geophysics carried out a long-term monitoring experiment gathering data about temperatures of the air, near surface and shallow ground under four different land coverings, namely bare clayey soil, sand, grass and asphalt. The aim of the project was to understand the heat exchange conditions at the air-solid earth interface and to reveal the dependence of the subsurface thermal regime on the surface cover material. Special attention focused on assessing the "temperature offset" (the difference between the air and the surface temperature) regarding various surface conditions and surface cover materials. The existing temperature records confirmed the present warming of the 0.12 K/yr (corresponding to Prague location) and compared with data from a typical farming locality in southern Bohemia supported the idea of certain anthropogenic contribution to the global warming.



A research polygon at The Institute of Geophysics.
Photo: The Institute of Geophysics of the CAS

The Institute of Atmospheric Physics gathered data and tested new methodology which allows the more precise definition than previously of wind conditions in the Czech Republic: The information is key for the rational use of wind energy. Atmospheric physicists also exposed strong relationships between spells of extremely high temperatures in summer and the character of precipitations, the knowledge of which can improve the development of climate models.



Sum of temperature deviations above the 95% quantile of summer maximum temperature distribution. Simulations were realistic only in the models including severe rainfall deficits. The C4IRCA3 and SMHIRCA climate models substantially overestimated the amount of precipitations during the heat wave, which resulted in unrealistic simulations of its temperature field.
Figure: The Institute of Atmospheric Physics of the CAS

The Institute of Geonics proposed optimum procedures for using abrasive water jets to cut titan and nickel alloys, ceramic and composite materials.

The Institute of Rock Structure and Mechanics began to digitalize its unique archive of more than 40,000 photographs, negatives and slides of landslides, debris flows, rock falls, unstable banks of water reservoirs and constructions and other geological catastrophes and dangerous natural phenomena. The digital archive is already available online at www.irsm.cas.cz/ext/qz/ and can serve geologists, construction engineers and the general public not only as a tool to observe the development of the landscape but also as a priceless photographic resource depicting significant historical, geomorphological and engineering-geological events.

II. Life and Chemical Sciences

Chemical Sciences

Institute of Analytical Chemistry
Institute of Inorganic Chemistry
Institute of Chemical Process Fundamentals
J. Heyrovsky Institute of Physical Chemistry
Institute of Macromolecular Chemistry
Institute of Organic Chemistry and Biochemistry

Throughout the year 2015, new scientific discoveries were announced by our Research Institutes conducting fundamental research into both organic and inorganic chemistry, physical chemistry, electrochemistry and chemical physics as well as into biochemistry. They contributed to the basic understanding of protein adsorption and desorption mechanisms on homogeneous and heterogeneous surfaces. A simple experimental method allowing to modify the electronic structure of a monolayer material was introduced, which is suitable for future applications particularly in optoelectronics. Researchers also described a previously unknown mechanism explaining the explosive behaviour of alkaline metals in water. They also overcame the key obstacle in studying the life-cycle of HIV viruses, as they succeeded in synchronizing the development of viral culture, thus enabling the study of HIV maturation.

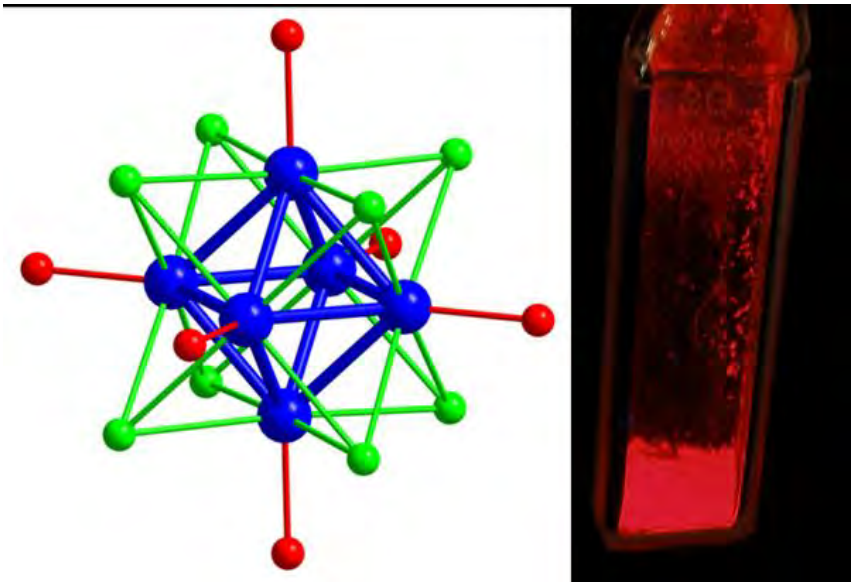
The Institute of Analytical Chemistry developed and built up a portable device for the rapid and highly sensitive analysis of explosives in the environment. The unique analyser allows the detection of even trace quantities of the overwhelming majority of substances present in explosives. Moreover, its internal power source secures autonomous operation for at least 10 hours.



Photo: The Institute of Analytical Chemistry of the CAS

A breakthrough in laser technologies was made by ***The Institute of Inorganic chemistry*** in co-operation with the Spanish National Research Council: they developed a new type of laser on a purely inorganic basis (i.e. entirely without carbon atoms) – a compound of boron and hydrogen, which emits a blue laser light from the solution. A borane, namely a solution of *anti*-$B_{18}H_{22}$, was used for the first time ever to produce laser light and this new borane laser

material exhibits significantly greater resistance to degradation as compared with many modern commercially available blue laser dyes. The institute also synthesized and studied molybdenum cluster compounds applicable for the development of X-ray inducible luminescent materials and sensitizers of singlet oxygen. The new findings seem promising for a photodynamic cancer therapy and for reducing doses of radiation needed to kill cancer cells.



Hexanuclear Molybdenum Clusters: a cluster structure (left) and red luminescence (right).
Figure: The Institute of Inorganic chemistry of the CAS

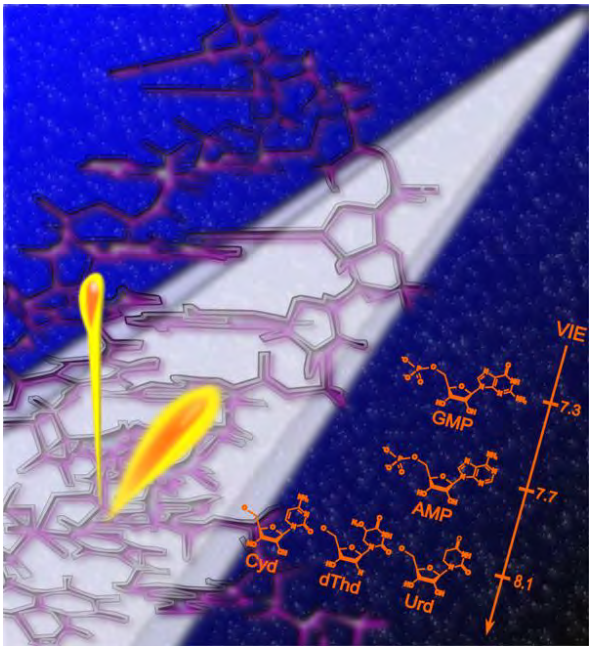
A team from ***The Institute of Chemical Process Fundamentals*** examined how dust and nanoparticles of chemical compounds in the air lead to the deterioration of precious collections at libraries and archives and devised measures for their protection.



Photo: The Institute of Chemical Process Fundamentals of the CAS

The J. Heyrovsky Institute of Physical Chemistry prepared new types of porous aluminosilicate materials or zeolites with special characteristics, the synthesis of which had been considered unfeasible, while ***The Institute of Macromolecular Chemistry*** made progress towards developing a new generation of vaccines based on hydrophilic conjugated polymers.

Ionizing radiation has significant harmful effects on DNA, causing strand breaks and nucleobase damage, which can lead to mutations and cancer. Researchers at ***The Institute of Organic Chemistry and Biochemistry*** investigated how big a dose of the ionizing radiation is necessary to cause a direct damage to DNA.



Determining ionization energies in DNA nucleobases in a native environment via photoelectron spectroscopy and quantum chemical calculations.
Figure: The Institute of Organic Chemistry and Biochemistry of the CAS

Biological and Medical Sciences

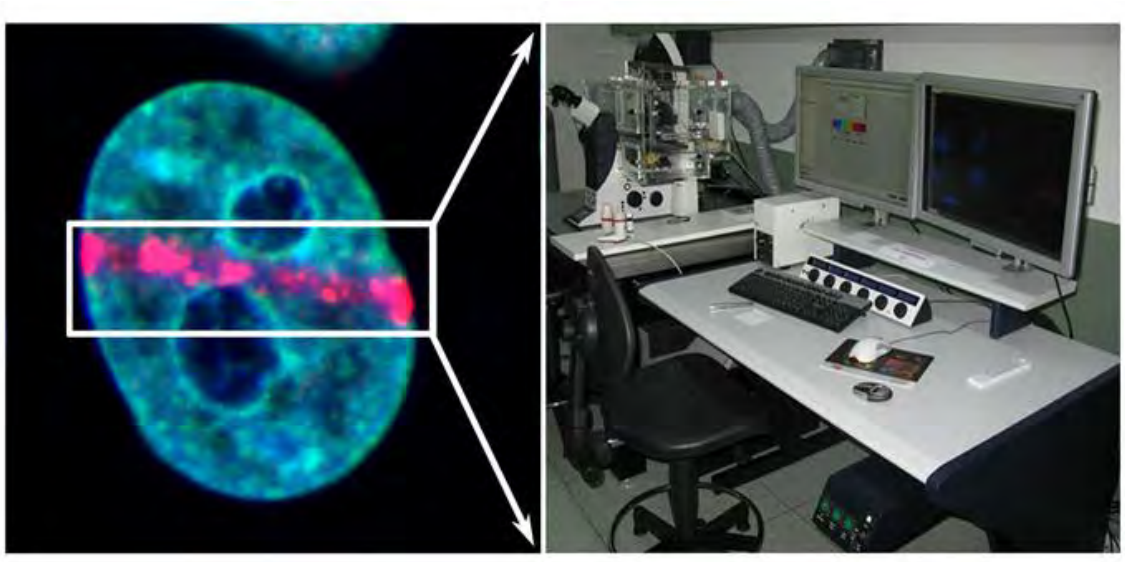
Institute of Biophysics
Institute of Biotechnology
Institute of Physiology
Institute of Microbiology
Institute of Experimental Botany
Institute of Experimental Medicine
Institute of Molecular Genetics
Institute of Animal Physiology and Genetics

Last year institutes orienting their studies primarily on processes taking place in living systems, from molecules through cells to whole organisms, threw new light upon

gastrointestinal immunity and the role of microorganisms in the onset of autoimmune diseases. The impact of atmospheric pollution on changes in gene expression was surveyed. Microbiologists studied one of the most fundamental processes on Earth – photosynthesis – and discovered another principle on which the photosynthetic II apparatus works in the cells of plants, algae and cyanobacteria and also offered a completely new view of the repair mechanisms in the photosystem II. They have also made a breakthrough discovery describing the physical nature of the conversion of light radiation to heat, which takes place in the light-harvesting complexes of plants.

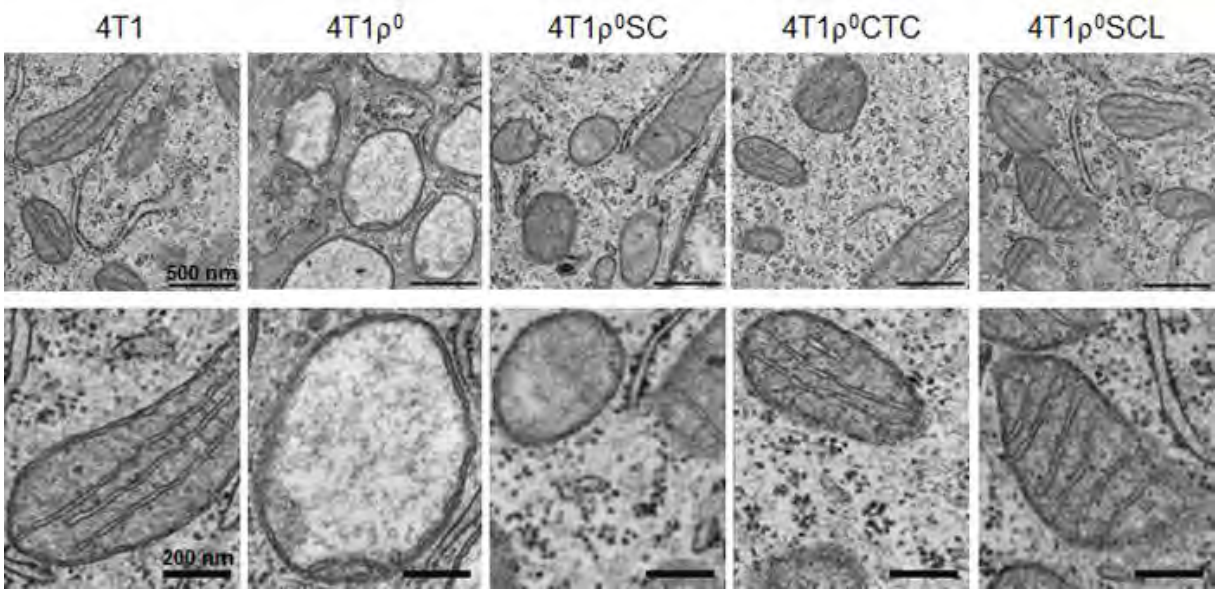
Researchers at ***The Institute of Experimental Botany*** contributed to unveiling an important mechanism of plant nutrition with nitrogen, examined and developed new biotechnology products, and focused their attention on antirheumatic and antiflogistic preparations.

The Institute of Biophysics was involved in surveying the biology of cell nuclei, including the repair of radiation damaged DNA, the biology of nuclear membranes. It was involved in the NuArch project studying the role of nuclear structural proteins not only in gene expression regulation, but especially in autophagy and DNA damage repair. Researchers also paid special attention to several nuclear proteins known to be implicated in a variety of rare diseases.



Phosphorylation of 53BP1 protein in human cancer cells (red fluorescence).
Photo: The Institute of Biophysics of the CAS

Tumour cells with seriously damaged mitochondrial DNA show delayed tumour growth. However, researchers at ***The Institute of Biotechnology*** found out that those tumour cells can acquire healthy mitochondrial DNA from host cells through horizontal transfer of whole mitochondria, recover mitochondrial respiration and grow tumours again. The fact that cancer cells have to recover their mitochondrial functions to grow new tumours indicate a new promising target for cancer treatment. Researchers from the Institute therefore prepared a number of substances targeted at mitochondria; their anti-cancer activity is currently being examined and one of the substances is ready for clinical trials.



Mitochondria.
Photo: The Institute of Biotechnology of the CAS

Details of insulin secretion stimulated by fat acids were described at ***The Institute of Physiology*** – which can help treat diabetes and diagnose pre-diabetic conditions in the future. Experts at ***The Institute of Molecular Genetics*** found out an enzyme which could play a decisive role in the development of ulcerative colitis. This new knowledge may lead to better diagnosis and later even therapy of inflammatory bowel disease.

Using unique monocolonized mouse models, scientists from ***The Institute of Microbiology*** and their colleagues in Lyon, France, have for the first time demonstrated the fundamental role of intestinal microbiota in the proper weight gain and longitudinal growth of infants and discovered the key molecule regulating the growth. Their findings outline new possibilities of fighting adverse effects of chronic undernutrition in children, mainly slow growth. Another team from the Institute described at the molecular level a unique mechanism exploited by the pathogen causing whooping cough to disable immune system cells of the host.

The damage of the ocular surface can result in impaired vision or even blindness. ***The Institute of Experimental Medicine*** therefore tested the therapeutic potential of mesenchymal stem cells and limbal epithelial stem cells for ocular surface reconstruction. Experts came to a conclusion that bone marrow-derived mesenchymal stem cells can serve those purposes in case autologous limbal epithelial stem cells are not available. Pathological functional and metabolic changes in the human auditory cortex typical of aging were also investigated at the Institute.

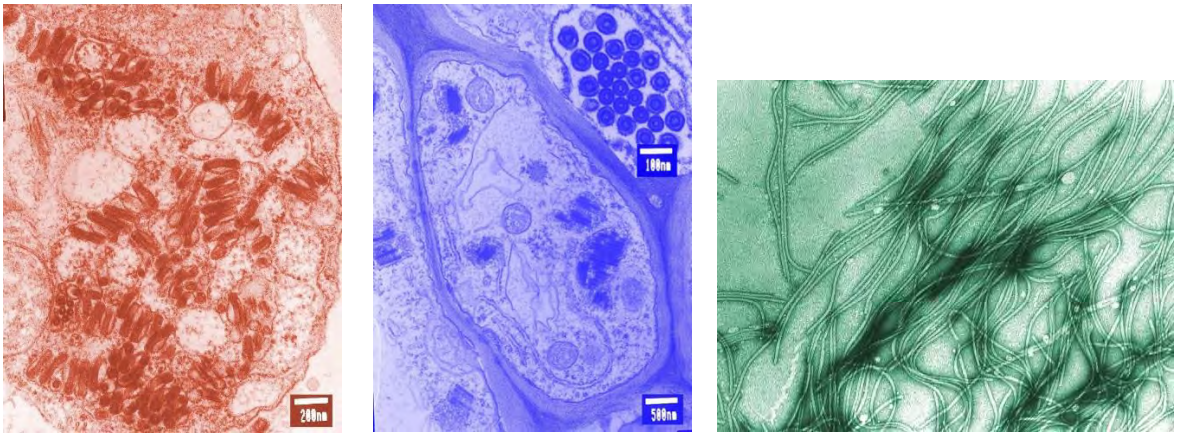
Using unique biomedical models – miniature pigs – The Laboratory of Cell Regeneration and Plasticity and the PIGMOD Centre of ***The Institute of Animal Physiology and Genetics*** made progress in studying fundamental causes of serious diseases, identify new biomarkers and search for new therapeutic methods to treat amyotrophic lateral sclerosis, traumatic spinal cord injury and human melanoma. Special transgenic minipigs carrying human

mutated huntingtin allowed researchers to continue to investigate in detail the fatal neurodegenerative disorder called Huntington's disease.

Biological-Ecological sciences

Biology Centre
Global Change Research Institute
Institute of Botany
Institute of Vertebrate Biology

In 2015, virologists from ***The Biology Centre*** identified and described new viruses attacking plants and fungi. Parasitologists studied in detail mitochondria of *Trypanosoma brucei*, which is a species of parasitic protozoan and causes fatal sleeping sickness – or African trypanosomiasis – in humans. In the past decade, they were also involved in the international project entitled *Survey of the tapeworms from vertebrate bowels of the earth*. On the basis of the gathered data the tapeworm classification is being revised, host-parasite relations of tapeworms determined – and the results are to be summed up in a monograph to be published in 2016. ***The Biology Centre*** also cleared up a long-standing issues in arthropod biology by presenting genetic evidence of a key receptor mediating the effects of juvenile hormones, which play critical roles in controlling the development and reproduction of insects and other arthropods.



New viruses discovered by The Biology Centre.
Photo: The Biology Centre of the CAS

An international team of biologists and ecologists from almost 40 institutions from all over the world, including ***The Institute of Botany***, carried out a comprehensive analysis of the worldwide distribution of alien plant species and their exchange among continents. Within the GloNAF (Global Naturalized Alien Flora) they compiled regional lists of naturalized plant species and produced a global database. Analyses from 481 continental regions and 362 ocean islands show that at least 13,168 plant species, that is 3.9 % of world flora, occur permanently outside the region of their original distribution. Thanks to the GloNAF database scientists can now start to identify the main biological mechanisms driving plant invasions and the naturalization of alien species.

The Institute of Botany was also involved in creating *Black, Grey and Watch Lists of Alien Species in the Czech Republic* based on distribution, invasion status, and known or estimated environmental impact of the listed species, which could help set priorities in the prevention, early warning and management systems.





Left: The Himalayan balsam *(Impatiens glandulifera)* is native in the Himalayas.
Right: Heartleaf Oxeye or Yellow Oxeye *(Telekia speciosa)* is native in Eastern Europe.
Photo: Jan Pergl, The Institute of Botany of the CAS

The Global Change Research Institute set up an interdisciplinary team focused on comprehensive research of drought and its impacts. The main outcome of the project is a system of monitoring and predicting drought to be used primarily by farmers, gardeners, fruit and vegetable growers and foresters. Updated Drought Intensity Maps are available at *www.intersucho.cz* both in Czech and in English and bring topical data about drought intensity predictions, relative soil saturation, soil saturation predictions, drought days, impacts on vegetation and yield in the Czech Republic and Slovakia; data covering the whole of Central Europe are in progress.

Ageing results from the accumulation of problems during molecular, cellular and physiological processes in the organism. To understand them better, ***The Institute of Vertebrate Biology*** studied extraordinarily rapid ageing – senescence – in African annual fish from the genus *Nothobranchius* characterized by its extremely short lifespan. Both laboratory and field investigations demonstrated rapid age-dependent functional decline and cellular and molecular changes comparable to those observed in other vertebrates, including humans. They helped understand the influence of environmental factors on the inter-species life-span variability in the Nothobranchius species.





A male of Turquoise Killifish (*Nothobranchius furzeri*).
A pool in the Mozambique savannah inhabited by the studied African annual fish from the genus *Nothobranchius.*
Photo:Marcel Honza, The Institute of Vertebrate Biology of the CAS

A team of experts from ***The Institute of Vertebrate Biology*** and other Czech and foreign institutions has found out that bats in Europe and Palearctic Asia, but not in North America, are protected against a fungal infection called the White-nose syndrome (WNS) by a special tolerance mechanism.





Left: The Czech WNS team examines a Bechstein's bat (*Myotis bechsteinii*).
Photo: Matej Dolinay, The Institute of Vertebrate Biology of the CAS
Right: A WNS-infected greater mouse-eared bat (*Myotis myotis*).
Photo: Jiří Pikula, The Institute of Vertebrate Biology of the CAS

III. Humanities and Social Sciences

Social and Economic Sciences

Main Library
Economics Institute
Institute of Psychology
Institute of Sociology
Institute of State and Law

In 2015 research Institutes in the area of social and economic sciences investigated topics related to the demographic ageing of Czech society and numerous ethical issues, including euthanasia. The life-long development of human beings was surveyed, as well as ways of caring for seniors. Levels of poverty in households in the Czech Republic and in other EU countries were investigated and global conflicts analysed in their local contexts. Sociological research methods were used to understand mechanisms underpinning instabilities of the housing market which were partly responsible for the recent global financial crisis.

The Main Library of the CAS for the first time became involved in the *Prague Museum Night* event and prepared guided tours of its premises and specialized exhibitions.

The Economics Institute paid special attention to the theory of Rational Inattention which argued that it was impossible for individuals to take into account all available information, their amount of attention was also limited, nevertheless, decisions had to be made. The Rational Inattention theory states that under certain circumstances, it is rational to ignore even useful pieces of information. Scientists investigated mechanisms used by rationally inattentive decision makers and their optimum strategy.

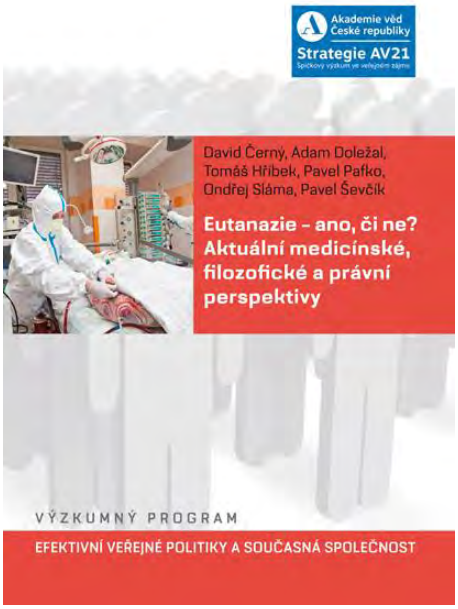
One of the major outcomes of ***The Institute of Psychology*** in 2015 was a study based on the unique 50-year-long research of people, who showed, among other things, that not only personality characteristics, but also their career stability, life satisfaction and well-being could to a certain extent be predicted on the basis of behaviour and personality traits observed in early childhood and adolescence. The results of this longitudinal study are useful to be applied in the psychology of upbringing, work organization and management. The research also formed the basis of a monograph *Personality and Well-Being Across the Life-Span* published by Palgrave Macmillan, UK.

The Institute of Sociology has been revealing how the care for the elderly is reflected in the public and political debate in the Czech Republic; how men and women taking care of an elderly family member describe and interpret their experience and to what extent their experience correspondes to the general framing of the problem.

One of the most serious and controversial issues of the present-day applied medicine – euthanasia – causes heated debates all over the world among physicians, philosophers, experts in ethics and theoreticians of law whether there are any circumstances under which euthanasia would be a morally acceptable choice at the end of human life. Examining this topic in the Czech Republic, ***The Institute of State and Law*** was addressing not only a narrow range of experts but Society as a whole. Discussions demonstrated that the very definition of euthanasia proved problematic and required further analysis. Researchers therefore prepared a monograph entitled *Easier Death? Philosophical and Legal*

Prerequisites for Euthanasia accentuating the philosophical and theoretical-legal approach to the topic. Two conferences were organized by the Institute for experts in the field of philosophy, medical ethics, law and medicine to try and find answers to what is euthanasia and what is not, how it can be defined, what any law on euthanasia should be like, and whether or not there is a difference between passive euthanasia and palliative treatment.





History Sciences

Institute of Archaeology, Brno
Institute of Archaeology, Prague
Institute of History
Masaryk Institute and Archives
Institute of Art History
Institute of Contemporary History

Last year historians, archaeologists and other experts dealing with both the distant and the immediate past introduced the public to new findings concerning the populations of Bohemia and Moravia from the middle to the late Palaeolithic periods. New data were gathered about the Roman period covering the first four centuries AD, during which our country found itself in the immediate neighbourhood of the fortified borders of the Roman Empire on the Danube basin, as well as about the genetic history of Europe in the early Middle Ages. Experts also presented an interactive archaeological atlas of Bohemia and a 3D virtual museum offering an unusual view of Neolithic culture *(www.archaeo3d.com)* and marked significant anniversaries related to the history of the Czech nation, its politics, philosophy, science and arts.



Figure: The Institute of Archaeology of the CAS, Prague.
http://www.archaeo3d.com/en/home/

In 2015 ***The Institute of Archaeology, Brno,*** completed a project conducting research into evolutionary anthropology. The international team of the project brought together fundamental findings relating to the mammoth hunter populations of Moravia and the examination of new settlements, which brought fresh evidence of a wide range of human activities, including settlement units, artefacts – tools and evidence of arts reflecting the spiritual life of those populations. Since 2013 the above-mentioned Institute has also been involved in the international project *aDNA – mapping of Longobard Period Europe – Genetic History & Medieval Studies*, studying the demography of early medieval migrations.



The site near in Cvikov in the Lusatian Mountains, North Bohemia, provided precious evidence of human settlements and the natural environment in the Middle Stone Age.
Photo: The Institute of Archaeology of the CAS, Brno

The project named *The Archaeological Map of the Czech Republic* was finished by ***The Institute of Archaeology, Prague*** in 2015 which resulted in the establishment of an interactive system gathering and managing data about the archaeological heritage of our territory. It is to serve not only theoretical research but it is also important for the protection of archaeological finds and monuments as well as the national and cultural identity of this country. Everybody interested in typical archaeological sites can also get acquainted with more than a hundred of them either in the book entitled *The Archaeological Atlas of Bohemia* or at its web page *www.archeologickyatlas.cz*, which offers more additional information on individual sites as well as digital maps to be downloaded for use in the field.

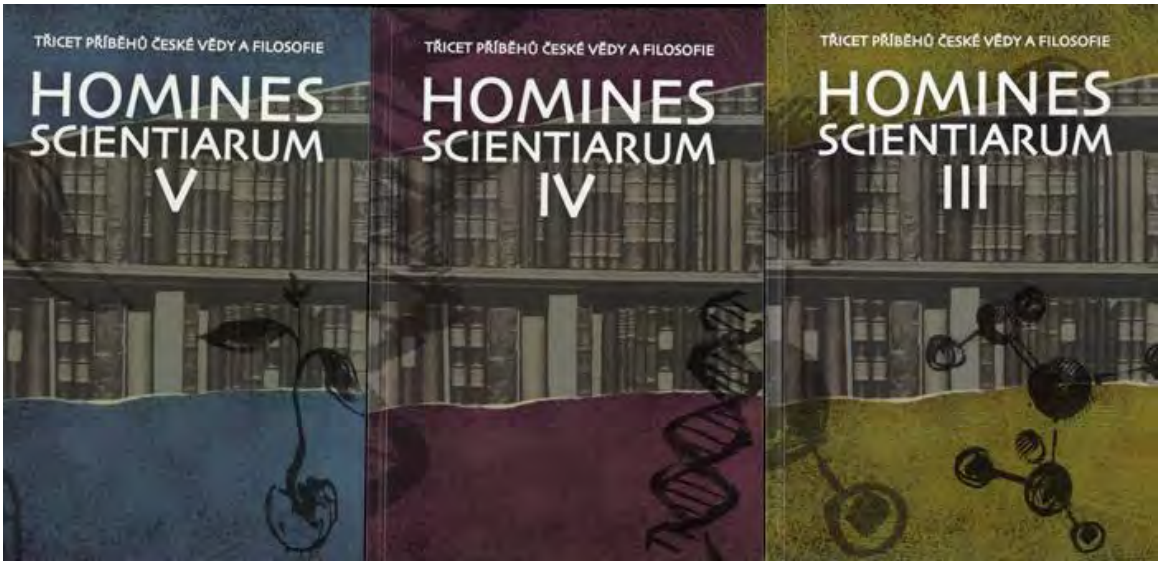


The book entitled *The Archaeological Atlas of Bohemia* has been completed with accompanying web pages at *www.archeologickyatlas.cz*, which can be downloaded and offer basic information about individual archaeological sites, maps and plans of the location, as well as photographs and even selected specialized full-text articles.
Figure: The Institute of Archaeology of the CAS, Prague; www.archeologickyatlas.cz

The Institute of History commemorated the 70th anniversary of the end of World War II and prepared a wide range of events both for scientists and the general public. They included an international scientific conference *On the Threshold of Freedom – Victory 1945* and an exhibition bearing the same name. The year 2015 also saw the conclusion of the project *Cartographic Sources as a Cultural Heritage. Research of the New Methods and Technologies of Digitalisation to Enable Access and Use of the Old Maps, Plans, Atlases and Globes.* One of its aims was to create an expert system of knowledge in the form of a web portal and to use the means of digitalization to allow experts to study valuable old documents without fear of damaging the originals and without the need to travel to respective archives, libraries or map collections.

The achievements of ***The Institute of Art History*** include a publication entitled *Rembrandt´s Tram: Cubism, Tradition and ´Other´Arts*. It was issued in conjunction with the exhibition of

the same name at the Gallery of West Bohemia in Pilsen, which offers a wide range of novel approaches to cubism and its connections with the arts in other continents and at different periods.



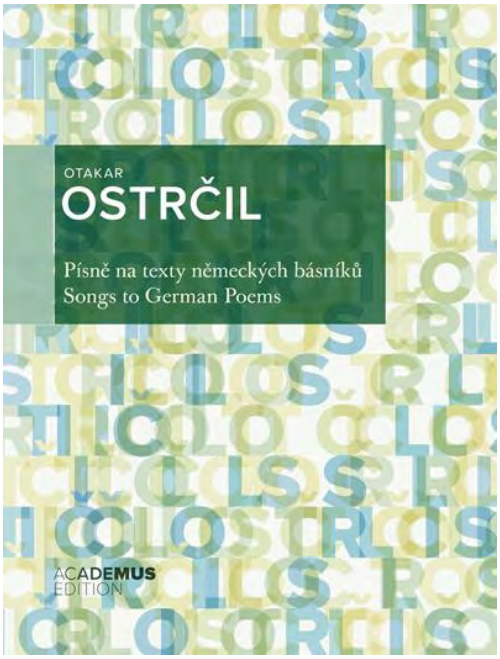
Homines Scientiarum – Thirty Stories of Czech Science and Philosophy – a work in five volumes and five DVDs offering thirty portraits of Czech scientists and intellectuals of the 20th century. ***The Institute of Contemporary History*** together with the University of Pardubice introduced readers to personalities from different branches of science who were active in different historical periods both at home and abroad. The publications even include evidence of imprisonment, prohibition, exile and other social and intellectual obstacles facing students and professionals in the 50s and 60s of the past century.

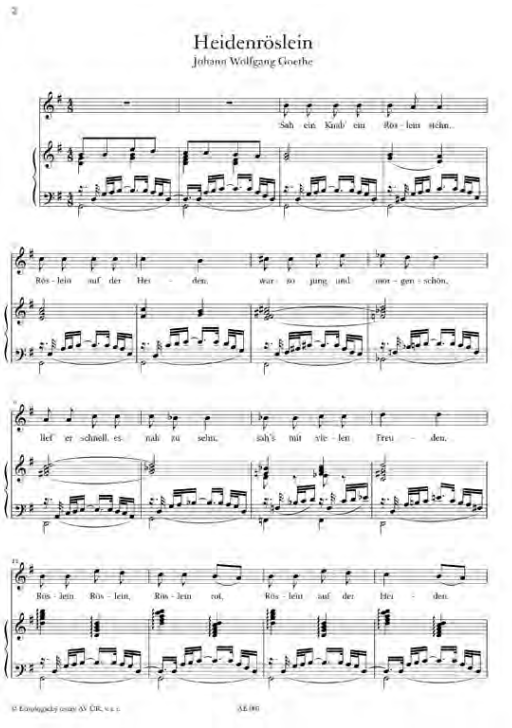
Humanities and Philology

Institute of Ethnology
Institute of Philosophy
Oriental Institute
Institute of Slavonic Studies
Institute of Czech Literature
Institute of the Czech Language

During the year 2015 the six institutes in this field of research issued a wide range of publications summarizing new findings in the realms of anthropology or ethnology, history of music and education. They were engaged in projects aimed at preserving written or audio recordings of outstanding personalities in our history. The first scientific work dealing with the phenomenon of what is called new playwriting was undertaken; the very first critical edition of an historical dictionary was published as well as a number of works discussing various topics of humanities and philology.

The Institute of Ethnology in co-operation with the European Association of Social Anthropologists (EASA) and the Czech Anthropological Society organized an international conference *Making Anthropology Matter* in October 2015, which attracted the most outstanding figures in European anthropology to discuss, among other topics, the ability of this branch of science to influence public opinion and influence highly religious societies, as well as the application of anthropologists´ knowledge during the current migration crisis as well as transformation processes in the former East European block countries.





From the first volume of the new *Academus Edition* launched by The Department of Music History of The Institute of Ethnology – *O. Ostrčil: Songs on the lyrics of German Poets. Figure: The Institute of Ethnology of the CAS*

The Jan Patočka Archive of ***The Institute of Philosophy*** continued the digitalization of authentic audio recordings of both official lectures and unofficial home seminars given by the outstanding Czech philosopher in the early 70s of the 20th century. Audio recordings were also transcribed and other parts of his lecture series were reconstructed from hand-written notes of participants. Jan Patočka´s contributions to phenomenology and the philosophy of history rank him among the leading philosophers of the 20th century. *http://goo.gl/btzJQ3 , stream/mp3, transkripce*

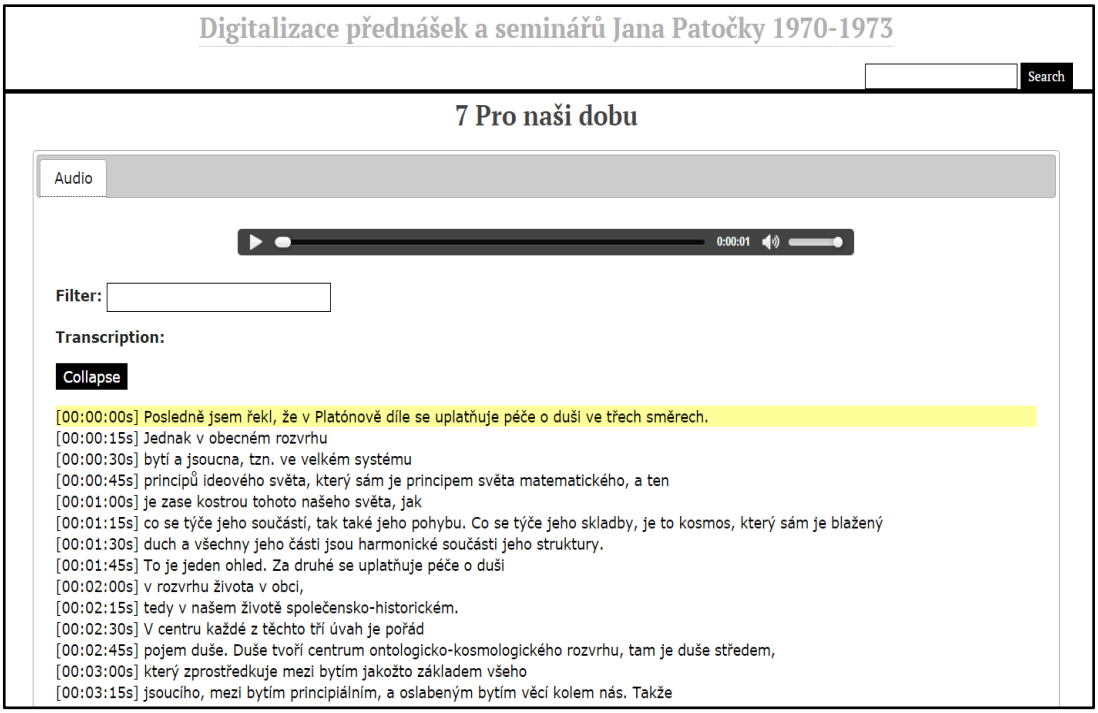


Figure: The Institute of Philosophy of the CAS

The Oriental Institute launched an interdisciplinary, comparative research project entitled *Power and Strategies of Social and Political Order* that addresses a wide range of questions pertinent to the study of various Asian and Middle Eastern societies from the ancient past to the present. Additionally it is to contribute to the improvement of historical, sociological, cultural and anthropological understanding of the emergence, stability and transformation of political and social structures. To facilitate the implementation of the project, the Research Center of *The Oriental Institute* was established at Academia Sinica in Taiwan in 2015.

An electronic version of the *Ukrainian-Czech Dictionary of Neologisms* was made available at *http://www.slu.cas.cz/ukrneo/ukrneo.html* by ***The Institute of Slavonic Studies.***

The Institute of Czech Literature introduced the general public to the first Czech scientific work devoted to various forms of censorship and the regulation of literature and the press from the onset of Enlightenment to the beginning of the 21st century. The outcome of the respective six-year project included a unique monograph *In the Common Interest: Censorship and the Social Regulation of Literature in Modern Czech Culture, 1749–2014*.

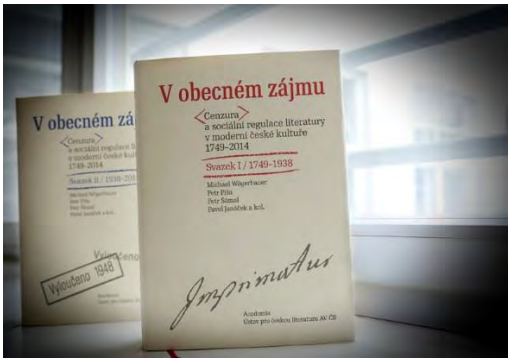
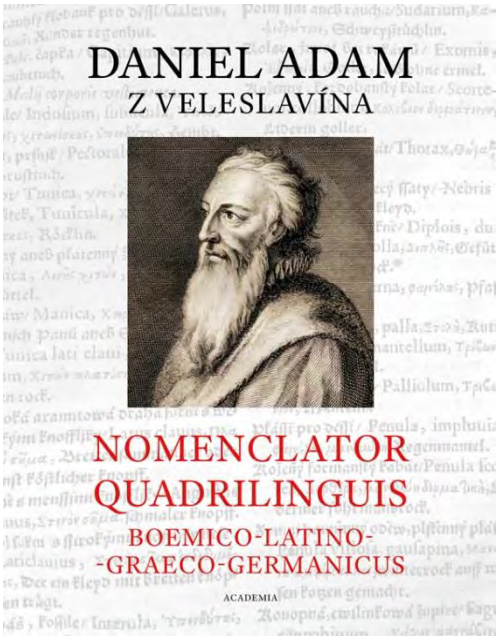


Photo: Stanislava Kyselová

The Institute of the Czech Language and the ***The Institute of Contemporary History*** contributed to preparing and publishing the work *Nomenclator quadrilinguis Boemico-Latino-Graeco-Germanicus* by Daniel Adam from Veleslavín, which was published for the first time in 1598. The new issue of the *Nomenclator* represents the first critical edition of a dictionary of this kind.



STRATEGY AV21

To perform top level research reflecting the needs of contemporary society and boost inter-institutional synergy, the CAS initiated its new *Strategy AV21*, the purpose of which is expressed in its motto: *Top Research in the Public Interest*. It aims at the pressing challenges facing humankind at present, including energy resources, human health, natural hazards and other complex problems, the solution of which requires multilateral interdisciplinary research involving not only different Institutes of the CAS, but also universities both in the Czech Republic and abroad, partners from a broad range of commercial companies, hospitals, museums, archives as well as state and local administration bodies. The backbone of *Strategy AV21* is formed by a set of co-ordinated research programmes. By the beginning of 2016, there were 15 of them. The significance of *Strategy AV21* and its targets is also stressed by the fact that it is implemented under the auspices of the Czech Premier, Bohuslav Sobotka. Individual multidisciplinary research programmes and expected outcomes are outlined in detail in a new publication *Strategy AV21*.

15 Research Programmes:

1. Hopes and risks of the digital era;
2. Systems for nuclear power industry;
3. Efficient energy conversion and storage;
4. Natural hazards;
5. New materials based on metals, ceramics and composites;
6. Diagnostic methods and techniques;
7. Well-being in health and disease;
8. Foods for the future;
9. Diversity of life and health of ecosystems;
10. Molecules and materials for life;
11. Europe and the State: between barbarism and civilization;
12. Memory in the digital age;
13. Effective public policies and contemporary society;
14. Forms and functions of communication;
15. Global conflicts and local interactions: cultural and social challenges.

Part and parcel of the activities included in *Strategy AV21* are workshops, conferences and other meetings that help spread research results from the realm of science to industry, medicine, state administration bodies and other spheres of Society:
Within the intentions of the *Foods for the Future* research programme, scientists, physicians, other experts and the general public met at a conference organized by ***The Institute of Microbiology*** under the title *Gluten-free Diet: Therapeutic Use and New Food Sources* to learn the latest findings concerning diseases caused by gluten intolerance and get acquainted with what plant breeders and food producers can do to offer gluten-free cereals and foods. Czech and European experts in Earth Sciences as well as professionals from civil protection bodies, representatives of the Senate and local authorities and private companies attended a workshop focused on landslides, debris flows, rock falls and other natural catastrophes and their impacts on society. The event was organized by ***The Institute of Rock Structure and Mechanics*** within the research program *Natural hazards* included in *Strategy AV21* and the participants discussed ways of protection from such natural hazards since climate change is expected to bring an increasing occurrence of weather extremes threatening the lives and properties of citizens.



A landslide in Hluboče, Brumov-Bylnice in the White Carpathian Mountains, spring 2006.
Photo: Jan Klimeš, The Institute of Rock Structure and Mechanics of the CAS

Technology Perspectives for Energy Storage was the name of another meeting organized by ***The Institute of Thermomechanics*** and ***The Institute of Chemical Process Fundamentals*** within *Strategy AV21* that brought together both Czech and foreign scientists, power industry leaders and government officials to outline technologies and trends of energy storage and ways of overcoming the disadvantages of the intermittent character of energy from renewable sources resulting from inconsistent solar radiation and wind.



From the conference *Technology Perspectives for Energy Storage*.
Photo: Stanislava Kyselová

The Institute of Computer Science, ***The Institute of Information Theory and Automation*** and ***The Institute of Mathematics*** launched a series of gatherings on *How to Defend Ourselves against the Risks of the Digital Era.*

Overcoming Global Threats: Enhancing Inter-cultural Dialogue, Stability and Peace was the title of the international conference held within the framework of the *Global Conflicts and Local Interactions: Cultural and Social Challenges* research programme of *Strategy AV21*. It was organized by ***The Oriental Institute, The Institute of Sociology*** and *Centre of Global Studies* of ***The Institute of Philosophy*** and addressed such issues as developing inter-cultural and intra-cultural dialogue, including inter-religious and intra-religious respect and discussions, enhancing justice, mutual cooperation and stability.



The international conference *Overcoming Global Threats: Enhancing Intercultural Dialogue, Stability and Peace* hosted by the CAS and the Czech Foreign Ministry.
Photo: Stanislava Kyselová

A number of projects started last year within *AV21* or with its support. Among them *The National Animal Genetic Bank* was established with ***The Institute of Vertebrate Biology*** as one of the founding members, the purpose of which is to continuously gather genomic material from a wide range of our fauna species and maintain them over a long period to establish conditions for mapping changes in their genetic diversity and conducting research.

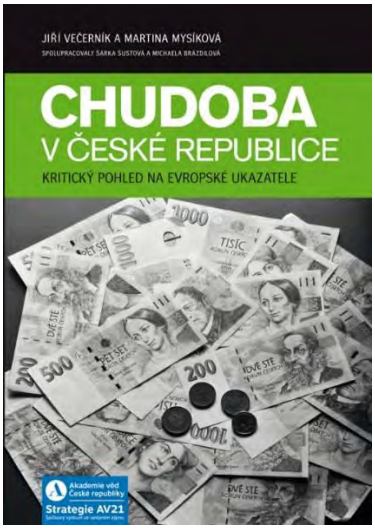


Male Moor Frogs develop blue coloration for a few days during the mating season.
Photo: Marián Polák, The Institute of Vertebrate Biology of the CAS

The *AV21* programme *New Materials Based on Metals, Ceramics and Composites*, coordinated by ***The Institute of Physics of Materials,*** got successfully underway and has already brought results which have been applied by industrial partners. It supports new promising trends in the field of material research. Researchers in the Institutes involved in this programme deal with functional engineering materials, magnetic shape memory and magnetocaloric materials, advanced metallic materials, metal based composites and so on.

As an example of inter-disciplinary research, ***The Institute of Experimental Medicine*** and ***The Institute of Physics*** prepared silica encapsulated cobalt zinc ferrite nanoparticles, tested their impact on DNA, lipids and proteins in living cells and showed that when applied at non-toxic doses, these nanoparticles represent a promising contrast agent and magnetic label for tracking transplanted cells within an organism using magnetic resonance imaging (MRI).

Among the hot topics studied within the *Effective Public Policies and Contemporary Society* research programme were *Demographic Aging (**The Economics Institute**)*, *Education, Education Policies and Labour Market (**The Economics Institute*** and ***The Institute of Sociology***), *Contemporary Ethics* (***The Institute of State and Law***) and many other issues. Researchers at ***The Institute of Sociology*** used both national and international data to compare different indicators of poverty and to compare the situation in the Czech Republic with other EU countries. They used the "subjective" poverty indicator, which takes into account not only income but also expenditures and other circumstances, and compared the percentage of people in households who report they are able make ends meet "with great difficulty". Based on this indicator, the Czech Republic maintains a very good place, ranked before other transition countries as a country with the lowest poverty – *Jiří Večerník, Martina Myslíková: Poverty in the Czech Republic: A Critical look at EU Indicators.*



A special edition of brochures was launched by the *Academia* publishing house to introduce in detail individual research programmes of the *Strategy AV21* and projects performed within them. They include ***Soil Degradation and Greenhouse Gas Emissions from the Soil and Agriculture –*** *a Necessary Evil?*, ***Alien Fish Species in the Waters of the Czech Republic*, *Euthanasia – Yes or Not?*** **and others, including the vitally important** ***Endocrine Disruptors*** *around us: the Threat of the 21st Century.*

NEW RESEARCH CENTRES AND FACILITIES OF THE CAS

The year 2015 saw the construction and enlargement of new research centres, facilities and laboratories as well as the modernization of their equipment which are to help accomplish the aims of the Czech Academy of Sciences.

Further construction stages of large infrastructures subsidized from EU funds through the Operational Programme Research and Development for Innovation, namely **ELI Beamlines** and **BIOCEV**, were completed.

The ceremonial opening in October 2015 officially finished the first implementation stage of **ELI Beamlines**, which is the international laser centre included in the European Extreme Light Infrastructure. Its construction in Dolní Břežany is headed and coordinated by ***The Institute of Physics*** and is to be equipped with the latest technology to carry out both research and application projects. In 2016 technological equipment has begun to be installed in the laser hall and, after testing, the entire centre is expected to be open for user research in January 2018. Unique high-performance laser systems of ELI Beamlines will generate light pulses capable of achieving an unprecedented intensity. Thanks to this, multidisciplinary research is expected to bring new knowledge in the field of biomedicine, the development and testing of new materials, imaging and diagnostic methods for medicine, optics, nanotechnology as well as in the field called "exotic physics". The centre has already significantly contributed to the interconnection between Czech science and top foreign research teams and has already led to the establishment of long-term co-operation between Czech, European and US firms and laboratories in developing and building unique laser systems.



The ceremonial opening of ELI Beamlines.
Photo: Stanislava Kyselová

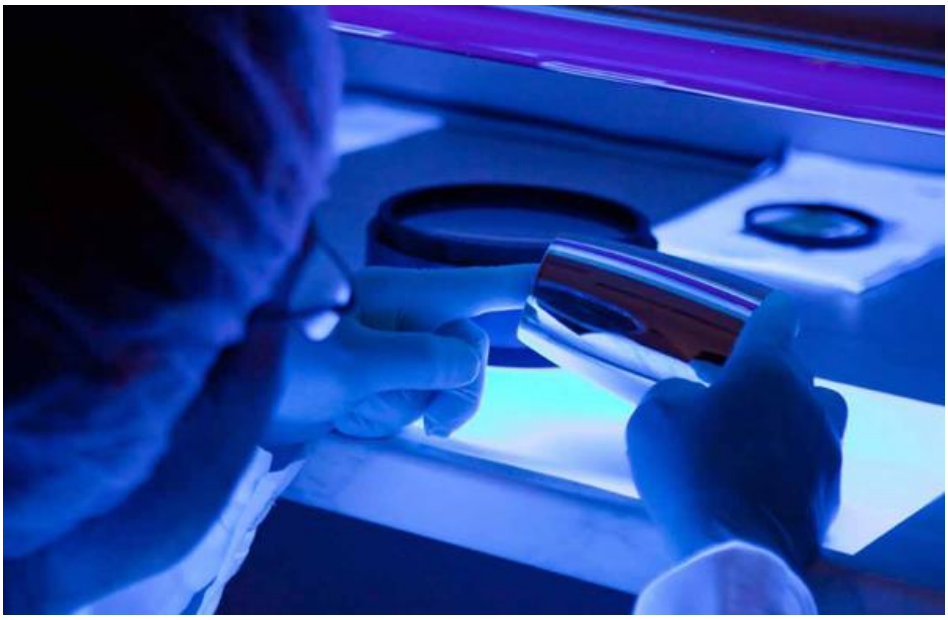
Moreover, the coordinator of the ELI Beamlines project, ***The Institute of Physics***, concluded an implementation stage of another international project – **High average power pulsed lasers (HiLASE): New Lasers for Industries and Research**, which deals with the development and application of top lasers and laser technologies with significant application potential in both research and industries – more efficient, more compact and stable than anywhere else in the world. They include primarily diode-pumped solid-state lasers with high pulse energy and high repetition frequency with parameters that are not currently available. Not only the HiLASE scientific potential, but also its very construction attract attention: its buildings won an award in the Construction of the Year 2015 contest. HiLASE is also located in Dolní Břežany, next to the ELI Beamlines complex, and they together make a new generation of research facilities.

BIOCEV – or the **Biotechnology and Biomedicine Centre** – in Vestec near Prague entered the trial operational phase in late 2015 and full operation began in January 2016. As a joint project of ***The Institute of Molecular Genetics***, five more CAS Institutes and two faculties of Charles University, BIOCEV is focused on biomedicine and biotechnology and explores the areas of functional genomics; cellular biology and virology; structural biology and protein engineering; biomaterials and tissue engineering as well as development of diagnostic and therapeutic procedures. These are designed to create an interconnected system of synergies and pay special attention to reproductive medicine, diabetes, autoimmune diseases, metabolic disorders etc. The BIOCEV research infrastructure and facilities are also open to external users to provide them with their research services.



The Biotechnology and Biomedicine Centre (BIOCEV) begins full operation.
Photo: BIOCEV

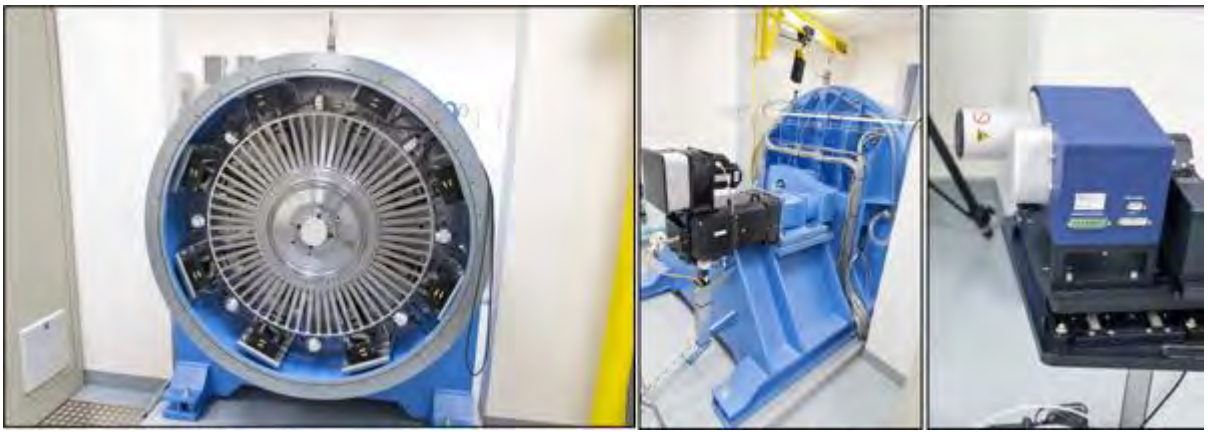
BIOCEV and several other recently established Centres of the CAS have entered the sustainability phase and in the coming years they will have to prove their financial self-sufficiency. This applies to centres like **ALISI** of ***The Institute of Scientific Instruments***, **ALGATECH** of ***The Institute of Microbiology*** near Třeboň or **TOPTEC** of ***The Institute of Plasma Physics*** in Turnov.



The TOPTEC Centre.
Photo: TOPTEC of The Institute of Plasma Physics

The Institute of Physiology completed the project of building its centre named **BrainView,** which is to study fundamental mechanisms underpinning neurodevelopmental and neurodegenerative disorders, such as autism, epilepsy, Alzheimer's and Parkinson's diseases, and open the way for finding possible treatments.

The Institute of Scientific Instruments opened a new laboratory of high resolution environmental microscopy **EREM** with a uniquely designed microscope to directly observe chemical reactions, which allows, for example, the analysis of effects of medical substances in the body. Since last year, ***The Institute of Rock Structure and Mechanics*** has been using its new **Centre for Texture Analysis** for studying rock characteristics and ***The Institute of Thermomechanics*** can now use its new **Laboratory of Rotational Laser Vibrometry**.



From the Laboratory of Rotational Laser Vibrometry.
Photo: The Institute of Thermomechanics of the CAS.

The Institute of Animal Physiology and Genetics completed the project **ExAM** (**Experimental Animal Models**) within the framework of which a new **PIGMOD** (**Pig Models of Diseases**) centre was established. It comprises of three laboratories focused on biomedical research using a unique animal model of serious diseases – miniature pigs. The scientists´ goal is to identify new sets of biomarkers and therapeutic methods first of all for traumatic spinal cord injury, Huntington´s disease and human melanoma.

SCIENCE FOR PRACTICAL APPLICATIONS

Research conducted at the existing Research Institutes of the CAS as well as in its newly established scientific centres and laboratories and particularly activities within the CAS *Strategy AV21* are increasingly oriented not only on enhancing fundamental knowledge in numerous branches of science, but also on transferring new scientific findings and newly developed technologies to practical use, be it in industries, medicine and environmental protection or in services and the state administration which can rely especially on examinations and reports worked out by experts in social sciences and humanities. Such application-oriented activities belong among the main tasks of the CAS and are reflected in direct contacts and co-operation between the CAS Institutes and partner organizations from the industrial sphere as well as with authorities at all levels, with the Chamber of Deputies and the Senate of the Parliament of the Czech Republic, state administration and local administration bodies (municipalities, town districts, towns, regions) and non-governmental organizations.

Support of technology transfer and coordination of the CAS activities related to practical applications is provided by the *Council for Cooperation of the CAS with Business and Application Spheres*. To increase the chances that newly acquired knowledge and research results are used as soon as possible is the objective of *The Centre for the Transfer of Technologies*, which was newly established within *The Centre of Administration and Operations of the CAS*.



CAS President Jiří Drahoš, Academy Council member Tomáš Kruml and director of The Centre of Administration and Operations, Jiří Malý, introducing the new Centre for the Transfer of Technologies.
Photo: Stanislava Kyselová

Assessing research results, joining science and industries, strategies of technological transfer and its development in the Czech Republic and abroad, establishing efficient co-operation between researchers and industries, introducing innovations into everyday life – these are some of the topics debated at the *Research and Applications* international conference that was organized by ***The Biology Centre*** of the CAS and attended by experts from the Massachusetts Technological Institute (MIT) in the US, the Max Planck Institute in Germany, Technopolis in Austria and others.

The CAS efforts to transfer research findings into practical outputs and its co-operation with partners in the industrial sphere are documented by numerous examples:

In 2015 the CAS Institutes submitted 64 patent applications in the Czech Republic, they were granted 58 patents and 47 utility models were registered in the Czech Republic. 7 licence agreements concerning intellectual properties were signed. 26 international patent applications were submitted abroad, 13 regional and 18 national patents were granted abroad etc.
The Institute of Physiology obtained a patent for antimicrobial peptides and their use for treating various local infections, including wounds difficult to heal or infections of mucous membranes, at cannula sites etc. A new way of mending damaged parts of roads with help of microwave heating was patented by ***The Institute of Chemical Process Fundamentals.***

The Institute of Physics received two of the four awards from The Technology Agency in 2015 – one for the project *New Single Crystal Materials Prepared with EFG Technology and Their Hi-tech Applications* carried out in cooperation with industrial partners. The respective team introduced the manufacturing process of new single crystal materials based on aluminium oxide and yttrium-aluminium oxide prepared by the Edge-film-growth (EFG) method, which could find use mainly in electronic, optical, optoelectronic and other high-tech applications, as well as in machinery and the jewellery industry. Among others, an active jewellery stone was developed transforming the radiation from near ultraviolet to visible spectral region. As a result, the jewellery made of it actively shines.
The other award was granted by the Technology Agency for the project *Synthetic multi-epitope vaccine against Lyme disease for veterinary applications* in which ***The Institute of Physics*** participated together with ***The Institute of Organic Chemistry and Biochemistry*** and other institutions.



An active jewellery stone based on Yttrium-Aluminium Garnet.
Photo: The Institute of Physics of the CAS.

The Institute of Scientific Instruments developed a non-invasive medical device for diagnosing the state of the vascular system.



The new medical diagnostic device developed at The Institute of Scientific Instruments.
Photo: The Institute of Scientific Instruments of the CAS.

Human health can also be protected thanks to the research carried out by ***The Institute of Chemical Process Fundamental*** which developed advanced thin film sensors for direct monitoring of time variables by means of precisely calibrated colour change – these can monitor (for example) certain types of radiation and by changing colour warn the hospital staff about exceeding the safe limit of irradiation; they can be calibrated to signal nearing the end of shelf-life for food, or the limits of expiration or light exposition of items in museums or archives etc.

The Institute of Botany has obtained a certificate for its newly developed methodology concerning the *Use of sewage sludge and biomass ash as a fertilizer for short-rotation coppice plantations.*

An apparatus designed by ***The Institute of Atmospheric Physics*** has been chosen by the European Space Agency for the surface platform of the planned ExoMars mission, which is to land on the red planet.

Using the technology of 3D scanning, ***The Institute of Archaeology, Prague*** created and launched the *Archaeological 3D Virtual Museum* at *www.archaeo3d.com* offering to anybody interested, in both Czech and English versions, an unusual view of the Neolithic world and its concept of culture, which is illustrated by the internet *Virtual 3D Museum of the Bylany site* – a location near Kutná Hora, where the earliest farmers lived for a period of an entire millennium, and apart from their houses and fields they also constructed large and mysterious circular structures.



Longhouses of the early farmers' culture in the European temperate zone as presented by the Archaeological 3D Virtual Museum.
Photo: Petr Vavrečka, The Institute of Archaeology of the CAS, Prague; http://www.archaeo3d.com/

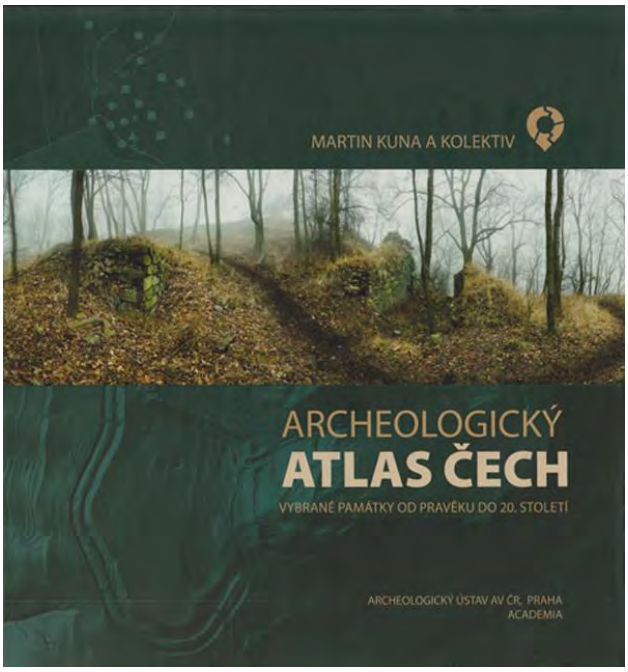
PUBLISHED BOOKS

The total of 185 books in the Czech language and 71 in foreign languages were published by the staff of the Czech Academy of Sciences in 2015. The final number is not yet complete, though, since publications dated 2015 are still being issued in 2016. The majority of them were composed at the Institutes of Humanities and Social Sciences.

Support for publishing selected research and books popularizing science written by its own staff, also experts from other research institutions and other authors is part and parcel of the CAS remit. In 2015, subsidy from the CAS amounted to almost 11 million CZK. This sum helped publish 54 titles, 35 of them by the *Academia* publishing house, which is a part of *The Centre of Administration and Operations of the CAS*, 19 by other CAS institutes. In this section we have used translated titles of the publications concerned, which are published in Czech. However, many of them were published in English or contain English summaries.

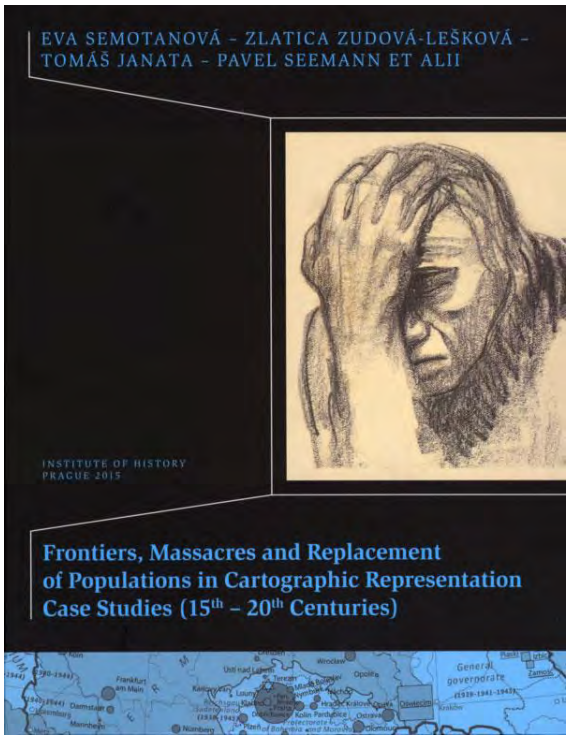
A number of publications issued last year mapped our prehistoric as well as recent past:

- The publication **An Archaeological Atlas of Bohemia: Selected Sites from Prehistory to the 20th century** by *Martin Kuna et al*. from ***The Institute of Archaeology, Prague***, won the title "Book of the Year" and became the absolute winner of the contest organized by the *Academia* publishing house;
- ***The Institute of Archaeology, Prague***, introduced a publication **Hradiště Oppidum near Stradonice** by *Jiří Militký*, which can be seen as a real milestone in our understanding of Bohemian Celtic coin production of the period of Celtic settlements called oppida, as it provides a complete list of all known coins as well as evidence of coin production found at the site of Stradonice Oppidum.



Archaeological Atlas of Bohemia

Researchers at ***The Institute of History*** continued to examine involuntary, forced migration or relocations of inhabitants – be it individual persons or entire population groups – both in Europe and outside this continent over centuries and the Institute published four books on this topic in English in 2015:
- *Zlatica Zudová-Lešková et alii.:* **Undaunted by Exile! To the Victims of Religious, Political, National and Racial Persecutions in Central Europe between the 16th and 20th Centuries with an Accent on the Czech Lands**;
- *Jan Němeček – Jan Kuklík*: **Frontiers, Minorities, Transfers, Expulsions: British diplomacy towards Czechoslovakia and Poland during WWII. Vol. I, Plans**;
- *Eva Semotanová – Zlatica Zudová-Lešková – Tomáš Janata – Pavel Seemann et alii.:* **Frontiers, massacres and replacement of populations in cartographic representation: case studies (15th–20th centuries)**.
- *Zlatica ZUDOVÁ-LEŠKOVÁ et alii.:* **Resettlement and extermination of the populations: a syndrome of modern history**.



A team of specialists in medieval and especially Hussite studies at ***The Institute of Philosophy*** reflected the fate and thoughts of Czech priest, philosopher and early Christian reformer Jan Hus, who was burned at the stake for heresy at the Council of Constance in 1415, which resulted in religious and social revolt in Bohemia that ushered in the European reformations of the 16th century. The book on the Czech theologian, reformer and martyr entitled **A companion to Jan Hus** and prepared by *František Šmahel* and *Ota Pavlíček as editors* was published in English by the prestigious *Brill* publishing house in Leiden.

What are the principal differences among diverse types of societies in various parts of the world in this global era? What is the role of us, as Europeans, in the present global order, especially face to face with the state of affairs in tropical Africa? How is that situation reflected in everyday reality by the local inhabitants and Europeans? These are some of the

questions asked by *Marek Hrubec* in his book **Society with the Safety Off (Odjištěná společnost)**, published by ***The Institute of Sociology***.



The achievements of this Institute also include a book **Why We Need a Family, Work and Friends. Happiness from the Perspective of Sociology** by *Dana Hamplová*. This empirically oriented work analyses data from international comparative studies examining the quality of life and concurrently strives to use data collected in extensive Czech quantitative research surveys and to show how happy people in the Czech Republic are, who of them are happier and who is not exactly satisfied.

The Vienna *Caesarpress* publishing house issued a collective monograph **Graffiti, Converts and Vigilantes: Islam Outside the Mainstream in Maritime Southeast Asia**, which was edited by the CAS expert in Indonesia *Tomáš Petrů* from ***The Oriental Institute***.

Research conducted at ***The Institute of Art History*** resulted in quite a few interesting publications, including a monograph **Modern Prague IV: a Large Guidebook to Architecture 1950–2000** by *Petr Kratochvíl, Zdeněk Lukeš* and *Pavel Hroch.*

Michael Wögerbauer, Petr Píša, Petr Šámal, Pavel Janáček and other members of the team from ***The Institute of Czech Literature*** authored a remarkable research publication **In Common Interest: Censorship and Social Regulation of Literature in Modern Czech Culture**. It thoroughly describes the phenomenon of restricting literary outputs from the beginning of the Enlightenment to the early 21st century and the overwhelming spread of the

internet. The book won first place in the category of original research or science-popularizing books in the contest organized by the *Academia* publishing house.

The Institute of Contemporary History represented itself with a series of books **Homines scientiarum: Thirty Stories of Czech Science and Philosophy, I–V** prepared by *Dominika Grygarová, Tomáš Hermann, Antonín Kostlán, Michal V. Šimůnek, Soňa Štrbáňová, Tomáš Petráň and Martin Čihák.* They offer a vivid picture of the lives of scientists and philosophers from a wide range of disciplines documenting Czech intellectual history in the past century.

Michal Kopeček and Piotr Wciślik (eds.) prepared **Thinking Through Transition: Liberal Democracy, Authoritarian Pasts, and Intellectual History in East Central Europe After 1989**, which explores the most recent chapter of East Central European past from the perspective of intellectual history. It was published in English by the *Central European University Press*.

THE ACADEMY AS A PARTNER

International Co-operation

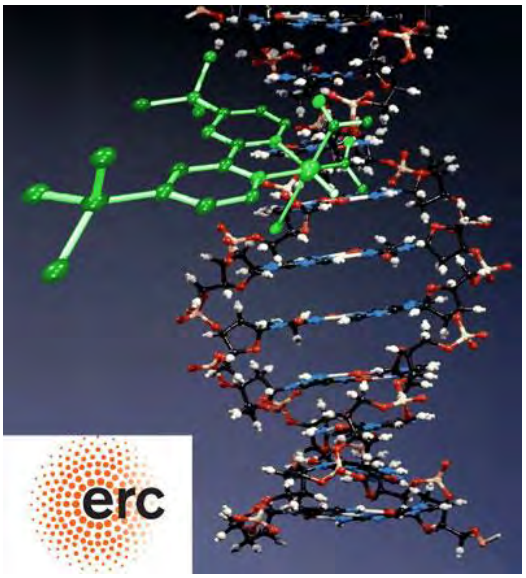
The first Czechoslovak president T. G. Masaryk´s statement that "Science is not collective, but co-operative" is increasingly more valid and the CAS considers international collaboration to be an inevitable prerequisite for both research and the evaluation of its activities on a long-term basis.

Active involvement in the European Research Area (ERA) and intensive expansion of European integration in research, development and innovations represent a guiding principle of the CAS. With this in mind, in 2015 it continued to co-operate with European and world organizations, including *The European Academies Science Advisory Council* (EASAC), *All European Academies* (ALLEA), the *International Council for Science* (ICSU) and the *InterAcademy Panel* (IAP). Czech researchers were active in large international research infrastructures, such as the *European Organization for Nuclear Research (CERN)*, the *European Molecular Biology Laboratory (EMBL)* and the *European Southern Observatory (ESO)*. Bilateral co-operation expanded with partner organizations in more than 40 countries.

In the year 2015 the CAS participated in 95 projects within the EU Seventh Framework Programme; apart from those supported through EU Operational Programmes mentioned before, i.e. ELI, HiLASE, BIOCEV, BrainView, ExAm these included projects aimed at strengthening competitive abilities or expanding capacities of the CAS research teams. Projects within the EU Seventh Framework Programme included among others: *Probing Strong Gravity by Black Holes Across the Range of Masses* co-ordinated by ***The Astronomical Institute*** and involving researchers from six European countries; *Advanced Materials for Batteries* implemented by ***The Institute of Macromolecular Chemistry*** and 15 more institutions from 8 European countries. Within projects supporting research is *LASERLAB EUROPE IV* co-ordinated by the University of Lund, Sweden, ***The Institute of Physics***, ***The Institute of Plasma Physics*** and 31 more institutions from 15 European countries.

The CAS also worked on 31 projects as part of the Horizon 2020 EU Research and Innovation Programme, one of which concentrated on *Aerosols, Clouds, and Trace Gases Research Infrastructure* with the aim of obtaining long-term data related to climate and the quality of the atmosphere, in which ***The Global Change Research Institute*** and ***The Institute of Chemical Process Fundamentals*** took part together with some 30 more institutions from 20 countries.

The p**rojects of the European Research Council included, among others:** *Feasibility, Logic and randomness in computational complexity* (***The Institute of Mathematics***), *Spin-charge Conversion and Spin Caloritronics at Hybrid Organic – Inorganic Interfaces* (***The Institute of Physics***), *Long-term Woodland Dynamics in Central Europe: from Estimations to a Realistic Model* (***The Institute of Botany***) and *Bioinorganic Chemistry for the Design of New Medicines* (***The Institute of Biophysics***).



From the *Bioinorganic Chemistry for the Design of New Medicines* project.
Figure:The Insitute of Biophysics of the CAS.

Last year several researchers from the CAS Institutes won prestigious grants from the European Research Council (ERC) to support the following projects: *Dicer-Dependent Defence in Mammals; Ecological Determinants of Tropical – Temperate Trends in Insect Diversity; Behavioral and Policy Implications of Rational Inattention*; *Smart Biologics: Developing New Tools in Glycobiology; Excitonic Magnetism in Strongly Correlated Materials.*

There were 304 projects either directly financed or grant-aided from abroad in the year 2015, including 189 as part of EU programmes.

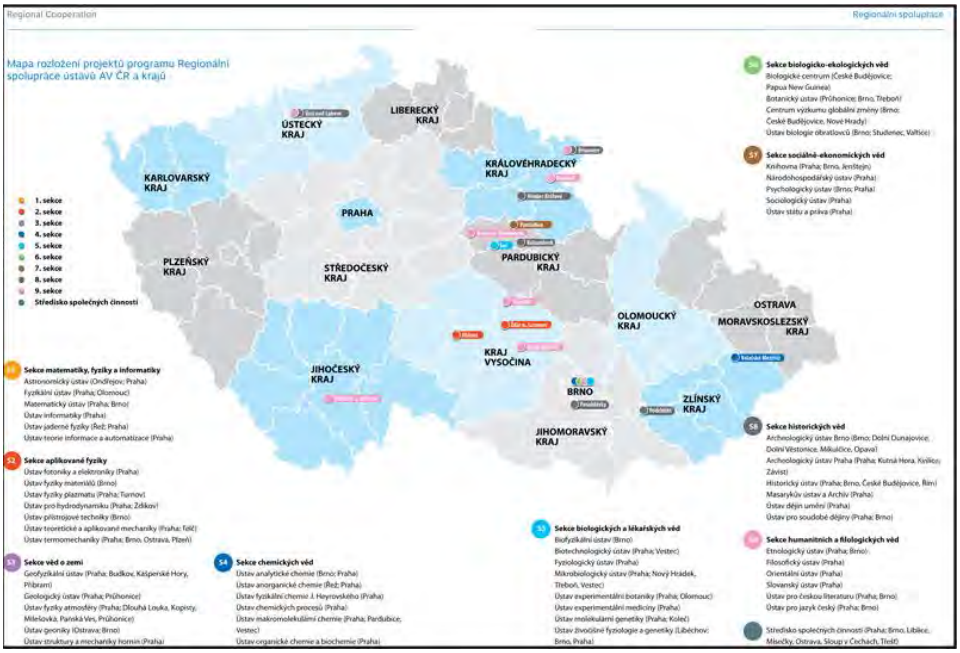
Researchers from the CAS Institutes took an active part in a number of scientific conferences and congresses in 2015, gave more than 3,800 lectures and other contributions and presented more than 2,800 research posters there. And vice-versa, a large number of international conferences, congresses, symposia and workshops attended by scientists from abroad was held in the Czech Republic and the CAS was the organizer or co-organizer of about 380 of them, including *Frontiers of Quantum and Mesoscopic Thermodynamics (FQMT'15)*; *17th International Conference on the Strength of Materials (ICSMA 17)*; *24th Annual Computational Neuroscience Meeting 2015*; *Conference on the Ecology of Soil Microorganisms* and *12th Conference of the European Sociological Association 2015* – to name at least a few.



Arlie R. Hochschild was one of the most distinguished guests at the 12th *Conference of the European Sociological Association (ESA)2015*.
Photo: ESA

Regional Co-operation

The CAS is highly interested in co-operation with regions, municipalities, universities, state-funded institutions and commercial companies as their partners.



A map charting projects within the regional co-operation programme of the CAS Institutes.
Figure: The Academy of Sciences of the CAS

22 joint projects carried out in 2015 included one searching for ways to relieve the impact of drought in South Moravia; others focused on algal blooms occurring in the Seč reservoir, conservation of wood in archaeological finds in The Highlands Region and so on.



An interdisciplinary project to rescue mural paintings and decorations at the Church of All Saints in Heřmánkovice near Broumov.
Photo: Omnium, o. s.

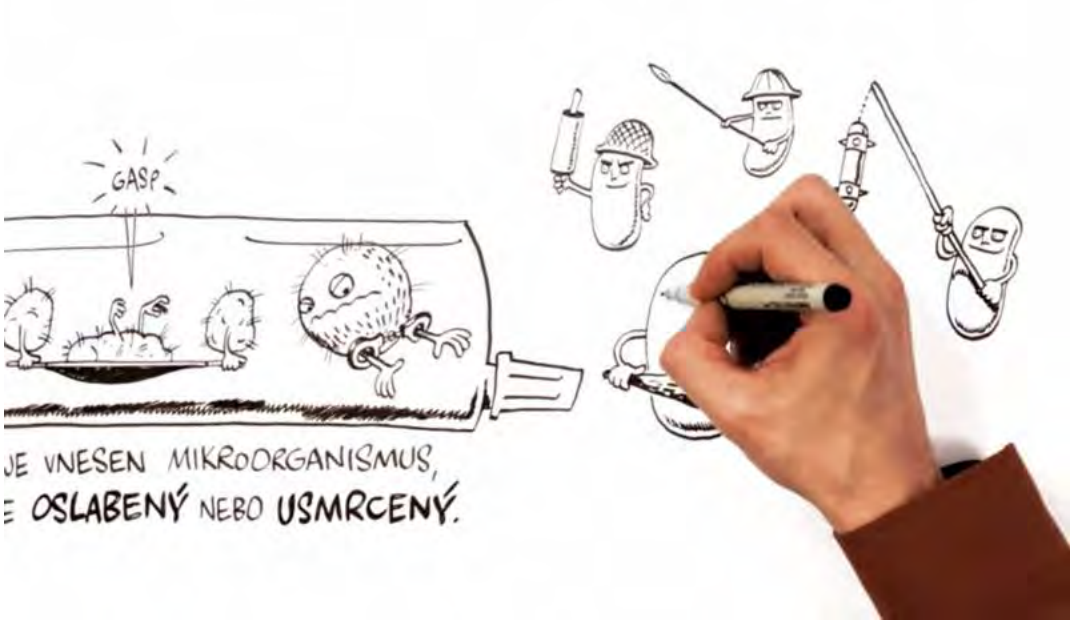
Co-operation with Educational Establishments

Apart from its research activities, the CAS makes every endeavour to help develop and increase the quality of education through co-operation with elementary and higher schools, universities, technical colleges and other educational institutions at all levels. Lectures, various courses, workshops, summer schools, knowledge contests and so on are integral to these efforts. The CAS researchers also participated in writing and publishing text books or preparing e-learning courses, supervising students' qualification theses performed at laboratories and Institutes of the CAS and so on. Last year 4,236 individual semester courses of lectures, seminars or practical exercises were provided at universities and technical colleges, totalling some 75,000 hours. The CAS researchers prepared a number of specialized seminars, series of lectures and other events for university students, such as the *UNESCO/IUPAC Postgraduate Course in Polymer Science* organized by ***The Institute of Macromolecular Chemistry***, practical training in archaeological research prepared by ***The Institute of Archaeology, Brno***, or an interdisciplinary *CENDARI Summer School – Researching Medieval Culture in a Digital Environment* held by ***The Institute of Philosophy*** and others.



One of the events at the New Mendelianum in Brno.
Photo: Mendelianum

The project entitled *Open Science IV – popularization of research and development and support to research-oriented teaching* was concluded in mid 2015. It offered lectures, special courses, student internship, lifelong learning courses for teachers and other educational activities. Study stays at the Institutes of the CAS and other research institutions were arranged for 73 secondary school, college and university students, they could work on their own research projects under the experts´ supervision and convey their results at another large event popularizing research and science – the *Science Fair.* Secondary school teachers of biology, physics and chemistry could learn new approaches in education and draw inspiration from *Summer Science Camp* to make their subjects even more attractive for students.



From the educational series entitled *NONdistorted Science*.
Figure: The Centre for Administration and Operations of the CAS

AWARDS AND MEDALS

The most significant awards to researchers of the CAS

In the year 2015, researchers of the CAS Institutes were granted a number of awards, medals and prizes appreciating the relevance of their work. They were awarded not only by the CAS, but also by other Czech and foreign scientific institutions as well as other state bodies. The most prominent ones include:

Awards bestowed by the CAS

Academic Award: Praemium Academiae

The Praemium Academiae is the pre-eminent and a rigorously selective award of the CAS intended as a means of financial and moral support to scientific excellence and outstanding scientists, whose research achieves the top international level and promises further extraordinary advancement, in order to help them further develop their potential. In 2015 it went to:

- **Michal Hocek** (*The Institute of Organic Chemistry and Biochemistry*);
- **Michal Pravenec** (*The Institute of Physiology*).

Michal Hocek heads a senior research team at *The Institute of Organic Chemistry and Biochemistry* that develops fundamental methods of synthesizing novel types of modified derivatives and analogues of nucleobases, nucleosides, nucleotides and nucleic acids designed and prepared with the use of modern methods, including metal- or enzyme-catalyzed reactions. He is renowned for his studies of cytostatic, antiviral and other biological activity of the novel nucleobases, nucleosides and nucleotides and their potential for applications in all areas of biomedicinal sciences, including medicinal chemistry, biochemistry, chemical biology, bioanalysis etc. He is the author or co-author of 190 publications in prestigious international journals with more than 3,000 independent quotations. He is also a full professor at the Department of Organic and Nuclear Chemistry of Charles University. The latest research projects of Michal Hocek´s group focus on so-called functionalized nucleic acids and their applications in bioanalysis, for example in the diagnostics of DNA mutations, chemical biology and nanotechnology. The Praemium Academiae enables Michal Hocek to further improve conditions for high quality research. One of the aims in the field of medicinal chemistry is to



Prof. Michal Hocek.
Photo: Stanislava Kyselová

thoroughly investigate a newly discovered group of nucleosides with cytostatic activity and to advance at least one substance to pre-clinical or even clinical testing.



Dr. Michal Pravenec.
Photo: Stanislava Kyselová

Michal Pravenec has obtained the Academic Award to continue to study what is called the metabolic syndrome – namely a group of risk factors that can lead to diabetes, heart disease and other health problems. He heads the department of the Genetics of Model Diseases at *The Institute of Physiology* and conducts research into the pathological conditions that are determined multifactorially, that is by many genes and their interactions with environmental effects. He is interested in risk factors for type 2 diabetes and cardiovascular disease, including obesity, hypertension, insulin resistance, and dyslipidemia and at identifying the networks and pathways of genes leading to disease susceptibility. Animal models of complex human diseases, particularly the spontaneously hypertensive rat (SHR) and special SHR-derived strains, are used to study essential hypertension and associated metabolic disturbances typical of metabolic syndrome. Michal Pravenec has played a significant role in the development of such unique biological models and he has also succeeded in revealing the first genetic determinants linked to hypertension, dyslipidemia and insulin resistance at a molecular level. Research projects of his team include, among other things, the study of the role played by inflammatory processes and oxidative stress in the pathogenesis of metabolic syndrome and the search for possible pharmacological interventions. At the same time, he is to continue to concentrate on identifying the molecular-based mechanisms of salt-dependent hypertension.

The Award of the CAS for outstanding achievements of great scientific significance were received by the following teams of researchers and authors:

● **Jan Palouš, Richard Wünsch**, **Soňa Ehlerová**, **Pavel Jáchym**, **Rhys Taylor**, **Adam Růžička**, **Vojtěch Sidorin** and **František Dinnbier** (*The Astronomical Institute)* for their scientific outcome *Star Formation in Galaxies*;
● **Petr Štěpánek**, **Sergey Filippov**, **Martin Hrubý**, **Jan Kučka** and **Jiří Pánek** (*The Institute of Macromolecular Chemistry*) for the scientific outcome *Supramolecular Structures and Self-association Processes of Polymers*;
● **Eva Semotanová** and **Jiří Cajthaml** (*The Institute of History*) for *An Academic Atlas of Czech History.*



Winners of *The Czech Academy of Sciences Awards* in 2015.
Photo: Stanislava Kyselová

The Award of the President of the CAS for the promotion and popularization of research, experimental development and innovation was granted to:
Helena Illnerová (*The Institute of Physiology*).

Twenty-one young experts received **The Otto Wichterle Premium to Young Scientists at the CAS:**

I. Mathematics, Physics and Earth Sciences:
Jaroslav Dudík (*The Astronomical Institute*), **Martin Ondráček** (*The Institute of Physics*), **Evgeniya Tereshina** (*The Institute of Physics*), **Ondřej Kreml** (*The Institute of Mathematics*), **Kamil Dedecius** (*The Institute of Information Theory and Automation*), **Andriy Ostapovets** (*The Institute of Physics of Materials*), **Jakub Urban** (*The Institute of Plasma Physics*).

II. Life and Chemical Sciences:
Martin Srnec (*The J. Heyrovsky Institute of Physical Chemistry*), **Elena Tomšík** (*The Institute of Macromolecular Chemistry*), **Ivana Šeděnková** (*The Institute of Macromolecular Chemistry*), **Evžen Bouřa** (*The Institute of Organic Chemistry and Biochemistry*), **Hana Macíčková Cahová** (*The Institute of Organic Chemistry and Biochemistry*), **Zdeněk Kubát** (*The Institute of Biophysics*), **Marta Vandrovcová** (*The Institute of Physiology*), **Helena Fulková** (*The Institute of Molecular Genetics*), **Tom Maurice Fayle** (*The Biology Centre*).

III. Humanities and Social Sciences:
Sylvie Graf (*The Institute of Psychology*), **Zuzana Uhde** (*The Institute of Sociology*), **Rudolf Kučera** (*The Masaryk Institute and Archives*), **Jan Bierhanzl** (*The Institute of Philosophy*), **Martin Hrdina** (*The Institute of Czech Literature*).

Awards granted by other institutions:



The Silver Commemorative Medal of the Senate of the Czech Parliament
Photo: Stanislava Kyselová

The Silver Commemorative Medal of the Senate of the Parliament of the Czech Republic was obtained by:

- **Armin Delong** (*The Institute of Scientific Instruments*)
- **Zdeněk Havlas** (*The Institute of Organic Chemistry and Biochemistry*)
- **Josef Syka** (*The Institute of Experimental Medicine*)
- **Karel Ulbrich** (*The Institute of Macromolecular Chemistry*)
- **Jiří Hejnar** (*The Institute of Molecular Genetics*)



Winners of *The Silver Commemorative Medal of the Senate of the Czech Parliament* in 2015.
Photo: Stanislava Kyselová

The Minister of Education, Youth and Sports´ Award for outstanding achievements in research, experimental development and innovation was granted to:
Petr Baldrian (*The Institute of Microbiology*).

The European Parliament – European Citizen's Prize 2015 was awarded to:
Marek Hrubec (*The Institute of Philosophy* and *The Institute of Sociology*).

The ´Czech Brain´ in the ´Doctorandus´ Category was obtained by:
Vítězslav Jarý (*The Institute of Physics*) for new materials which can be used for the detection of invisible ionizing radiation.

Neuron Awards for the Contribution to Science were granted by the **Neuron Fund for Support of Science** to:
Eduard Feireisl (*The Institute of Mathematics*); **Hynek Němec** (*The Institute of Physics*); **Anna Fučíková** (*The Institute of Physics*) and **Jana Dobrovolná** (*The Institute of Molecular Genetics*).

The List of **Highly Cited Researchers** issued by ISI Thomson Reuters included the names of three professors from the CAS in 2015: **Pavel Hobza** (*The Institute of Organic Chemistry and Biochemistry*), **Petr Pyšek** (*The Institute of Botany*) and the late **Vojtěch Jarošík** (*The Institute of Botany*).

Pavel Hobza was ranked among the top 1% of researchers in the world with the most cited documents in the field of chemistry. He has authored or co-authored more than 500 papers and 3 books that have been cited more than 30,000 times. He is a holder of the Distinguished Chair in Computational Chemistry at *The Institute of Organic Chemistry and Biochemistry* in Prague, he is a professor in physical chemistry at Charles University in Prague and at Palacký University in Olomouc. He has won world renown thanks to his discovery of so-called improper hydrogen bonding, thanks to which science textbooks had to be rewritten. His research interests focus particularly on non-covalent bonds and interactions, which play an important role in chemistry, physics and especially in biosciences, since they determine the structure of biomacromolecules – not only proteins, but also nucleic acids (RNA and DNA) and they are also responsible for molecular-recognition process. Their study is therefore crucial for understanding fundamental biological processes. To learn the proper role of molecular interactions also requires quantum chemical studies and the development of new computational techniques and methods for calculating and modelling non-covalent interactions, structure and dynamics of molecular and biomolecular clusters, hydrogen-bonding and other processes, which also constitute an important part of Pavel Hobza´s research activities as he has become one of the world´s top computational chemists.



Prof. Pavel Hobza.
Photo: Stanislava Kyselová



Prof. Petr Pyšek.
Photo: Stanislava Kyselová

Petr Pyšek heads the Department of Invasion Ecology at *The Institute of Botany* of the CAS and is a professor at the Department of Ecology, Faculty of Science, Charles University in Prague. He has won international renown for his outstanding contribution to understanding the causes and consequences of biological invasions in the world and discoveries concerning plant ecology and ecology of invasive species. His research activities are oriented particularly at macro-ecological and other factors determining the spread and naturalization success of alien species, their invasiveness, the diversity and composition of alien flora in different regions. He deals with species diversity, temporal trends and geographical patterns of alien flora of Europe and has been involved in international projects focused on the research of alien and invasive plants, including DAISIE (*Delivering Alien Invasive Species Inventories for Europe)* or ALARM (*Assessing Large-scale Environmental Risk for Biodiversity with Tested Methods).* He has contributed to the

development of the *EICAT* or *Environmental Impact Classification for Alien Taxa* scheme, which represents an objective and simple method for assessing alien species in terms of their environmental impacts in recipient areas and offers guidelines for implementing this method. Most recently he was engaged in a comprehensive analysis of the worldwide distribution of alien plant species and their exchange among continents and building the global database of them within the GloNAF (*Global Naturalized Alien Flora*) project.

SUPPORTING YOUNG SCIENTISTS AND EQUAL OPPORTUNITIES

To create the best possible conditions for young experts to develop and use their talents in favour of science – that is the driving force behind numerous activities of the CAS aimed at young people. They can begin with lectures given by experienced scientists at universities through various seminars, courses and other specialized events focused on the education of students and young scientists, such as summer schools, postgraduate courses and workshops, to supervising students and their qualification theses performed at the laboratories and Institutes of the CAS. The *Courses in the Fundamentals of Research Work* designed for students in doctorial study programmes are also in great demand. In 2015 they were held four times in Prague, where they were attended by 94 students, and four times in Brno, where they attracted 147 young people.

Last year the EURAXESS Centre at the *CAS Centre of Administration and Operations* again provided help to foreign researchers – both young and experienced – in joining in the work of research institutes in the Czech Republic.

As an act of motivation, the *Otto Wichterle Premium* is traditionally awarded to exceptionally promising young scientists at the CAS for their remarkable contributions to the advancement of scientific knowledge. In 2015 this financial support was granted to 21 young experts who were not older than 35 in the calendar year when the nominations were submitted (in case they had been on maternity or fraternity leaves, the age limit was postponed accordingly).



Winners of *The Otto Wichterle Premium* in 2015.
Photo: Stanislava Kyselová

Apart from that, the CAS and its Institutes use a number of other financial incentives to assist young scientists, such as a special programme of wage support to postdoctoral fellows, which covered 67 junior scientists in 2015. They can also take advantage of EU funds through the *Education for Competitiveness Operational Programmes* under the jurisdiction of the Ministry of Education, Youth and Sports of the Czech Republic, which allowed, as an example, for the establishment of new positions and educational and laboratory facilities for postdoctoral fellows. Last year saw the first financial support granted to cover the costs of numerous international summer and winter schools, courses, workshops and other research and educational activities organized by the CAS Institutes for young researchers and students.

The CAS also strives to enhance equal opportunities for both men and women in science, and does so in both theoretical and practical manners. An independent department, *Gender and Sociology,* has been established within *The Institute of Sociology* to develop the concept of gender-orientated sociology. The urgency of this problem was further underlined by its latest reports monitoring the situation of women in Czech science, which were published in 2015.

SCIENCE AND THE PUBLIC

125th Anniversary of the Czech Academy of Sciences

Celebrations of the 125th anniversary of the foundation of ´The Czech Academy of Emperor Franz Josef I for Sciences, Literature and Art´, the predecessor of today's CAS, were the highlight of the CAS social activities throughout the whole of 2015. The jubilee was commemorated by a number of ceremonial events, conferences, exhibitions and lectures, beginning with a **Ceremonial Session in t**he main hall of the Wallenstein Palace and a Ceremonial Opening at the Convent of St Agnes in Prague. Then *Videomapping* – a video projection on the walls of the CAS main building on Národní třída in Prague – acquainted the general public with selected historical milestones of the CAS and its important scientific personalities. The CAS and its activities were also documented by the interactive exhibitions *Science and Technology: An Adventure that Will Entertain You!* staged at the National Technical Museum in Prague and *Botanical Stories (The World of Plants – From Knowledge to Use)* displayed at Průhonice Castle and the Botanical Garden of Chotobuz. Most CAS Institutes got involved in the celebrations: they took part in an exhibition entitled *Science – Nation – History* staged at the National Museum, which introduced not only the history of the Academy of Sciences, but also its current activities. Within the celebrations of its 125th anniversary the CAS also hosted a prestigious international conference *Non-University Research: Present and Future* attended by representatives of top European non-university institutions, including ALLEA (All European Academies) or the Max Planck Society in Germany.



From the Gala Evening concluding the celebrations marking the 125th anniversary of the Academy of Sciences.
Photo: Stanislava Kyselová

The activities of the Czech (and Czechoslovak) Academy of Sciences in the promotion and presentation of free thought from the 1950s to the present were shown at the exhibition displayed at the National Library of Technology under the title *Ways May Differ*.

A series of events – from conferences through exhibitions to books – commemorated the 70th anniversary of the end of World War II, such as exhibitions *On the Threshold of Freedom: Victory 1945* and *The Protectorate and its End.*

In 2015 the CAS and its Institutes also paid homage to the Czech priest, philosopher and early Christian reformer, Jan Hus, who was burned at the stake for heresy 600 years ago – and the CAS and its institutes organized and staged lectures, publications, exhibitions and conferences, including an international one entitled *Hus – Hussite Movement – Tradition – Prague; from Reality to Myth and Back.*



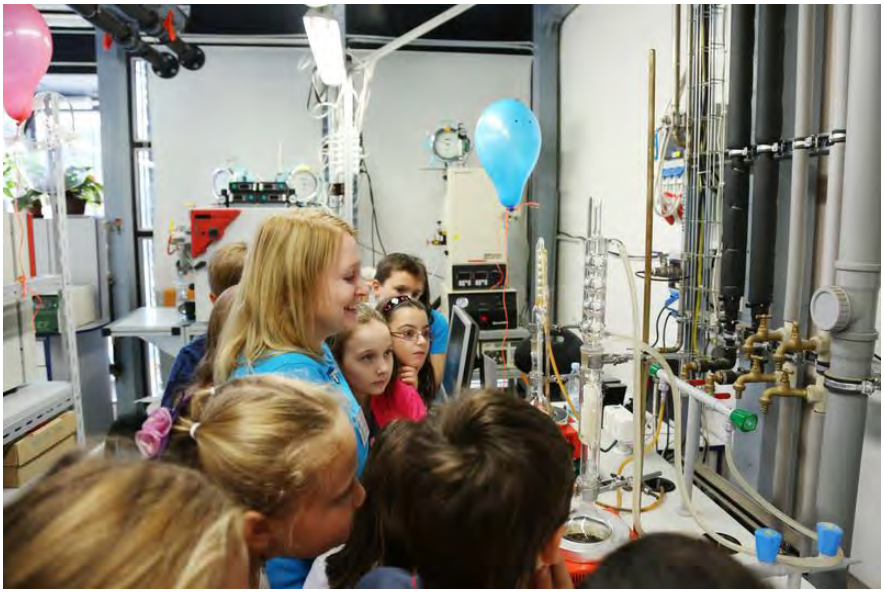
The exhibition *The Three Lives of Jan Hus: Scholar and Reformer, Heretic and Saint, National Hero*.
Photo: Stanislava Kyselová

Science Communication

The popularization of science and research areas and achievements has become an integral part of the activities of the CAS and is exercised through both specialized centres (*The Centre of Administration and Operations*, *The Division of Media Communication of the CAS*

Head Office, *The Library* and others) and individual institutes. Special emphasis is placed on systematic work with students and elementary and secondary school teachers.

2015 was designated as *The International Year of Light and Light-Based Technologies* and *The International Year of Soils* – both were mirrored in numerous popularization activities, including the traditionally largest science festival, *The Week of Science and Technology (WST CAS).* It attracted more than 124,000 visitors to over 500 events all over the Czech Republic offering lectures, Science Cafés, exhibitions, seminars, documentary film screenings, open house days and excursions to laboratories.



From the largest science festival organized for the general public – *The CAS Week of Science and Technology* – in 2015.
Photo: Stanislava Kyselová



Light Is Life exhibition marking *The International Year of Light and Light-Based Technologies*.
Photo: Stanislava Kyselová

Events attractive to the general public also included the 17th *Brain Awareness Week* organized by *The Institute of Experimental Medicine*. A wide and varied range of other events staged by eleven of the CAS Institutes within the *Spring Excursions to the World of Science* was attended by more than 5,000 visitors who grasped the opportunity to carry out a time-travel with archaeologists and historians, to get acquainted with possible ways of resolving the world shortage of energy in the near future at *The Institute of Plasma Physics*, to learn more about 400 species of plants typical of our rivers, meadows, ponds, marshlands and peat bogs at *The Institute of Botany* in Třeboň, and to see laboratories of microbiologists etc.



2015 was also *The International Year of Soils*.
Photo: The Biology Centre of the CAS, v. v. i.

The CAS presented is successes at the world *EXPO 2015* held in Milan, Italy. *The Institute of Organic Chemistry and Biochemistry* acquainted visitors with its search for new therapeutics against modern civilization´s – or so-called lifestyle – diseases. *The Institute of Experimental Botany*, whose researchers have substantially contributed to sequencing the wheat genome, offered an insight into the DNA structure of cultivated crops. On display was also the first electron microscope from *The Institute of Scientific Instruments. The Institute of Botany* took part in preparing a live exhibition of plants – *The Laboratory of Silence* – showing a biotope of a Czech forest.



From *The Echoes of EXPO 2015* exhibition staged at the CAS Science and Arts Gallery *in 2015.*
Photo: Stanislava Kyselová

Science and the Arts

Science and the arts are intertwined – as has already been documented by the above-mentioned exhibitions staged by the CAS to mark various anniversaries. A number of other presentations were mounted by *The Centre of Administration and Operations* and other CAS Institutes and departments to demonstrate scientific discoveries as well as artworks by the scientists themselves. Several of these exhibitions, including the one called *Light is Life*, were devoted to *The International Year of Light and Light-Based Technologies* and showed research in all possible frequencies of the electromagnetic spectrum, including lasers, fibre optics and numerous other optical technologies used in everyday practice.

The Axis of Avant-guarde Prague was the name of an exhibition which riveted extraordinary interest. It was co-organized by *The Centre of Administration and Operations*, *The Institute of Czech Literature* and other partners and invited visitors to go for a walk through the capital city between the years 1900–1945. Another exhibition – *Voyages inside the Earth* – prepared by *The Institute of Geophysics* documented outcomes of outstanding international projects of deep boring and exploratory drilling aimed at discovering the structure of planet Earth and understanding the processes of its interior, which is crucial for protection against

natural hazards, for ensuring supplies of water and minerals for the burgeoning world population and so on.



Drilling in the Dead Sea – from the *Voyages Inside the Earth* exhibition.
Photo: The Institute of Geophysics of the CAS

In 2015 the CAS and its Institutes also participated in organizing exhibitions held outside their own premises – and throughout the whole of the Czech Republic – here we name two of the many:

- The Gallery of West Bohemia in Pilsen and *The Institute of Art History* set up the first comprehensive presentation of the 17th and 18th century fine art in West Bohemia at an outstanding exhibition staged under the title *Nobility & Piety: Baroque Art in the Pilsen Region and West Bohemia*.
- *The Institute of Slavonic studies* was among the organizers of a unique exhibition of works of art by Russian painters of the 19th and the early 20th centuries. Under the name *FAR/ NEAR. Ilja Repin and Russian Art* it displayed more than 120 pictures and pieces of graphic arts, 3 of them borrowed by the famous Tretyakov gallery in Moscow.

THE CZECH ACADEMY OF SCIENCES IN 2016

The year 2016 is still constantly bringing new scientific findings, conferences and other gatherings of scientists, which cannot, however, be fully reflected in this publication, since it was prepared long before the year drew to a close. It nevertheless strives to highlight some pivotal aims and trends of the CAS and draw attention to the most significant scientific and social events to which the Academy attaches special importance.

The CAS in 2016 – Pivotal events

A wide range of events, from exhibitions through specialized scientific conferences to straightforward festivities, organized or co-organized by the CAS commemorate and celebrate the 700th anniversary of the birth of **Charles IV**, King of Bohemia (1346 to 1378) and Holy Roman Emperor (1355–1378), who not only consolidated the country politically, but was also instrumental in the enormous expansion of its culture, including the establishment of the first university in Central Europe in Prague. The Czech Academy of Sciences joined forces with the Senate of the Czech Parliament to assemble an exhibition *The Legacy of Charles IV throughout the Centuries*, which reminded us of his spiritual legacy and highlighted his deeds and the consequences of his reign for contemporary societies not only in the Czech Republic but the whole of Europe. A number of other events have and will introduce Charles IV as an outstanding political and diplomatic figure and demonstrate his enormous influence through his patronage of the arts, culture, education and architecture. This applies, among others, to the exhibition staged at the CAS premises under the title *Seven Towers: Charles IV through the Eyes of Academicians (1316–2016)*, which displayed both the past and current research into the period of Charles IV.



Launching the exhibition *Seven Towers: Charles IV through the Eyes of Academicians (1316–2016)*.
Photo: Stanislava Kyselová



A replica of the Charles IV statue displayed at the exhibition *Seven Towers: Charles IV through the Eyes of Academicians (1316–2016)*. The original statue was made for the Old Town Bridge Tower designed by Petr Parléř circa 1380.
Photo: Stanislava Kyselová

The international conference organized by *The Institute of History* and Charles University, meeting in late September 2016, is to focus on the evolution of this famous sovereign´s foreign policy.



The Slavonic Monastery of Charles IV – an exhibition staged at the Emmaus monastery.
Photo: Stanislava Kyselová

The CAS also celebrated the 700th anniversary of the birth of Charles IV with a ceremonial lecture given by Professor František Šmahel and entitled *Emperor Charles IV and Master of Theology Jan Hus: a Survey of Bohemian History in the Late Middle Ages*. This particular lecture has opened a series in which eminent Czech and world scientists address pressing social issues. The second lecture in the series was by Professor Jaroslav Doležel from *The Institute of Experimental Botany* on the following topic: *Can Genetics Save Humankind from Hunger? – 150 Years since Gregor Johann Mendel´s Discoveries*.

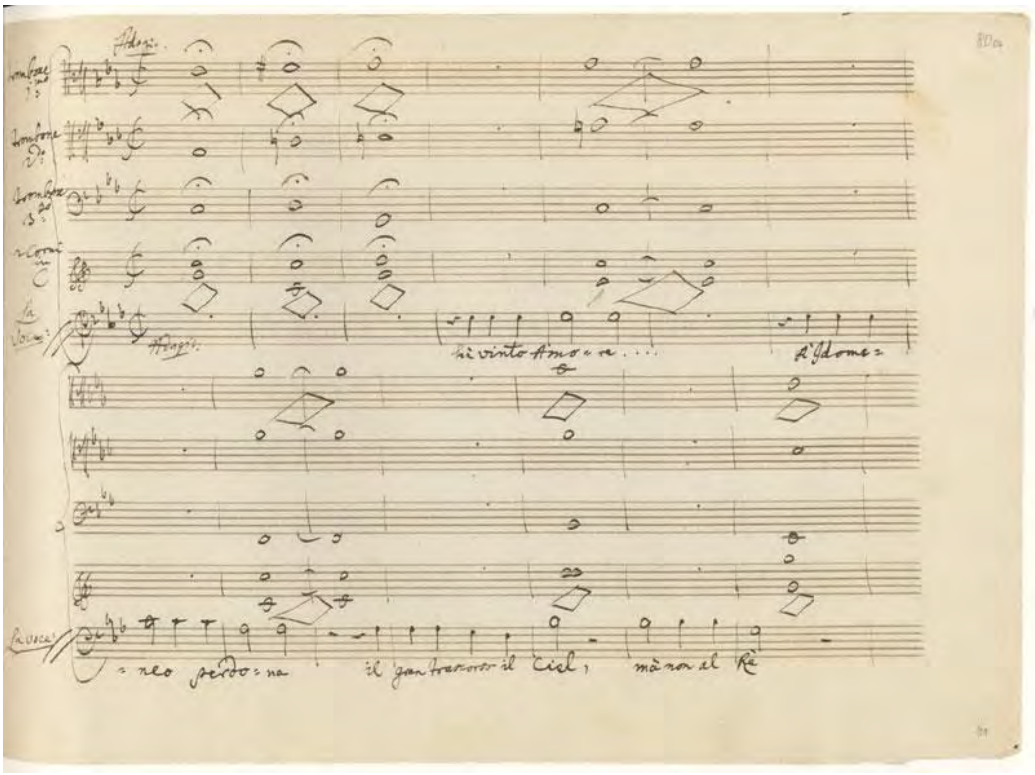


The ceremonial lecture given by Professor F. Šmahel: *Emperor Charles IV and Master of Theology Jan Hus*.
Photo: Stanislava Kyselová

Among other events scheduled for the year 2016 is the CAS commemoration of the 260th anniversary of **Wolfgang Amadeus Mozart**'s birth and the 225th anniversary of his death. On this occasion the Mozart Society in Czech Republic and the Don Juan Archiv in Vienna held the **international conference *Current Issues of Mozart Research***, which discussed the topics of Mozart´s operas and his compositional techniques in comparison with Italian productions of that time, librettos and libretto studies and suchlike.

The Institute of Philosophy has marked the 100th anniversary of the birth of **Samuel Beckett** by organizing an international symposium *Chaos and Form: Echoes of Beckett in Literature, Theatre and the Arts*.

The *Academia* publishing house, which is a part of *The Centre of Administration and Operations* of the CAS, has celebrated its 50th anniversary. To mark the event it presented an almanac mapping all of the almost 5,000 titles issued by this publishing house, including scientific monographs, works by Czech and foreign researchers, science-popularizing books, encyclopaedias, dictionaries etc.



The first page of the longest version of Mozart´s **Oracle** in the autograph score from the Archives of The Institute of Ethnology.
Figure: The Institute of Ethnology of the CAS

The CAS in 2016 – Science and Research

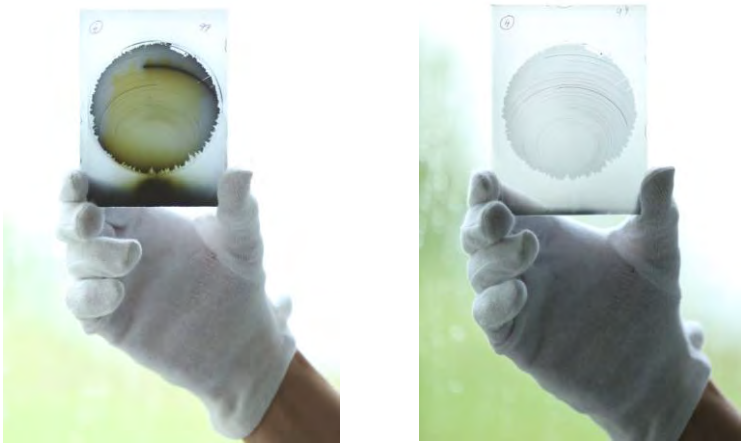
International Co-operation

The year 2016 witnesses the expansion of co-operation of the CAS and its Institutes with foreign institutions and other partners. For example, closer co-operation has been established with Florida International University and with the Chinese Academy of Social Sciences. The General Assembly of the ICOS has approved the admission of the Czech Republic, as represented by *The Global Change Research Institute* of the CAS, into its European Research Infrastructure Consortium (ERIC).

This year also offers a wide range of international scientific congresses, conferences, symposia, summer schools and other events in various fields of science, including the conference *Overcoming Global Threats: Enhancing Inter-cultural Dialogue, Stability and Peace*, organized under the auspices of the Minister of Foreign Affairs at the main building of the CAS by *The Institute of Philosophy* and *The Oriental Institute* in cooperation with ambassadors of Muslim countries. Its aim was to address hot issues of enhancing inter-cultural dialogue, mutual cooperation and stability, prerequisites for resolving political, religious, military and other conflicts as well as releasing scientists´ potential to contribute to inter and intra-religious dialogue.

The Institute of Thermomechanics hosted the conference *Topical Problems of Fluid Mechanics 2016*. Astronomers, physicists, chemists and other experts gathered at the

International Workshop on the Scientific Use, Digitization and Preservation of Astronomical Photographic records co-organized by *The Astronomical Institute*.



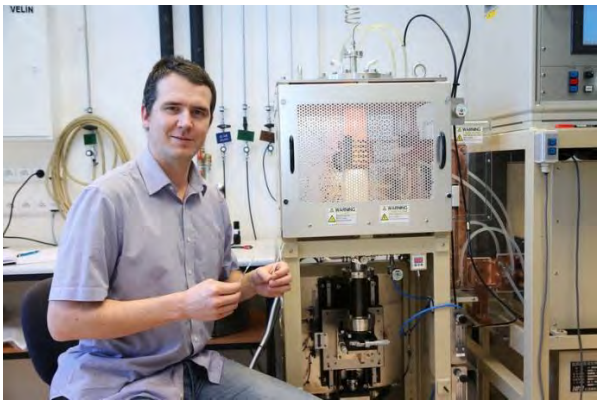
The *International workshop on the scientific use, digitization and preservation of astronomical photographic records* addressed the issue of photographic plates and negatives damaged by inadequate storage conditions. The yellow film on an astronomical photographic plate (left) shows the damage – compared to an undamaged one (right).
Photo: Stanislava Kyselová

BIOCEV has invited specialists to discuss the latest findings in their field at the *International Symposium Devoted to Recent Discoveries in Haematology of Myeloproliferative Diseases*. *The Institute of Scientific Instruments* has prepared *The 15th International Conference on Recent Trends in Charged Particle Optics and Surface Physics Instrumentation*. These eclectic examples are but a few of the wide range of specialized and scientifically highly valuable events staged in the year 2016.

Projects

This year again sees numerous projects which have been launched or, on the contrary, are coming to their conclusion and bring fundamental results, out of which only a few can be mentioned here:

A European project called *ASCIMAT* started at ***The Institute of Physics*** with the aim of developing and tailoring scintillator materials, which are able to transform energy deposited by ionizing radiation (gamma rays, X-rays, and the higher ultraviolet part of the electromagnetic spectrum) into visible or UV light that can be efficiently detected by photomultipliers or semiconductor detectors. This is then transformed into electric signals and processed. These materials are increasingly important both in research and in many practical applications, including medical imaging technologies. Crystals for various scintillation materials are to be grown with the use of a unique micro-pulling down technology.

Co-ordinator of the ASCIMAT Project Martin Nikl (left), Jan Pejchal sitting next to the apparatus for the micro-pulling-down crystal growth technique (right).
Photo: Stanislava Kyselová

Rationality and Deliberation is the title of the project launched by ***The Institute of Information Theory and Automation*** that tackles the problem of decision-making under uncertainty. The rapid development of information and computer technology and multiple, very frequently incompatible sources of information overload decision-makers. Their cognitive, information and evaluation capabilities are, however, limited – nevertheless they are supposed to make decisions. In this situation even separation of important and unimportant information may require a significant deliberation effort. The project aims at presenting a theory and a method facilitating complex dynamic decision making under uncertainty and with incomplete knowledge.

By the end of 2016 two broad interdisciplinary projects dealing with potential climate change impacts and coordinated by ***The Global Change Research Institute*** are to be completed. The first – *UrbanAdapt* or *Development of Urban Adaptation Strategies Using Ecosystem-based Approaches to Adaptation* concentrates on assessing climate change vulnerability, identifying and initiating appropriate cost-effective measures in three pilot cities in the Czech Republic: Prague, Brno and Pilsen. It aims at reducing the risk of floods and soil erosion, improving water and air quality as well as rainwater management and decreasing the urban Heat-island-effect.



The *UrbanAdapt* project working group.
Photo: Czech Globe - The Global Change Research Institute of the CAS

The second project called *CzechAdapt* or *System for Exchange of Information on Climate Change Impacts, Vulnerability and Adaptation Measures on the Territory of the Czech Republic* is to create and verify, in an experimental operation, an information system as well as an open, continuously updated on-line database gathering available scientific data and recommendations for adaptation and instructions in a user-friendly form. Users can already find topical data and a survey of possible climate change mitigation and adaptation measures in the fields of agriculture, forestry, hydrology, power industry and human health at *www.klimatickazmena.cz***.**

Researchers from ***The Institute of Czech Literature*** began to implement their project, *A History of Czech Literature under the Protectorate of Bohemia and Moravia*, the ambition of which is to interpret and to put in a broader context authorship and literary output between March 15, 1939 and May 9, 1945. This was the time when the political and cultural life in Bohemia and Moravia were determined by the imposition of the German occupation and the unfolding of World War II, since this period remains somewhat forgotten and unexplored. Although attention turns primarily towards Czech literature created and published within the Protectorate, nevertheless Czech exile literature as well as Czech-German publications and works in German related to the period and territory in question are also examined. The three-year project is to be completed with a book which is expected to be published in late 2018.

The Institute of Art History has obtained a grant to implement a project devoted to one of the most eminent Czech photographers Josef Sudek **(1896–1976)** and entitled *Josef Sudek and Photographic Documentation of Works of Art: From Personal Art Archives to the Representation of Cultural Heritage*. An international symposium about this outstanding personality and his work is to take place in late 2016 as well as an exhibition of his photographs depicting the ateliers of Prague artists from approximately 1930 to 1960 and works of art by painters, sculptors, graphic artists and product designers from that period, including those of Andrej Bělocvětov, Josef Wagner, Josef Mařatka and Bohumil Kafka.



A photograph from the exhibition entitled *Josef Sudek: Ateliers*. The atelier of Andrej Bělocvětov.
Photo: The Institute of Art History of the CAS

The interdisciplinary project *Dynamics of Change in Czech Society* undertaken by ***The Institute of Sociology***, ***The Economics Institute*** and Masaryk University analyses the economic and housing situation of households, their private and professional lives, education, leisure time activities, social stratification, housing inequalities and other features. The first year of research involved respondents over 15 years of age from more than 5,000 households in 2015; the same are addressed in 2016 to help determine the development of Czech Society in the course of time. The first results yielded by the project show, for instance, that although money is important for Czech people, nevertheless they consider certainty and stability of employment as the principal factor in searching for a new job: 62% of the respondents also highly appreciate the possibility of better harmonizing their private and professional lives.

The CAS and Society

The 2nd *Science Fair* staged by the CAS Institutes, universities, museums, science centres and other institutions popularizing science attracted some 14,000 visitors to Prague-Letňany to touch, smell, see, hear and even taste science: they could hear the story of lightbulbs or get acquainted with lasers and their usage in both today´s everyday life and non-traditional applications or watch robots and drones at work; they also had a chance to learn why paper disintegrates in libraries and archives, to watch spectacular physical and chemical experiments or even try eating at the ´molecular´ bar and to taste sweets after they had been immersed in a vacuum. Unlike last year, the *2016 Science Fair* also introduced the fruits of research in social sciences and humanities, such as archaeology, psychology, sociology, literature and philosophy.



The 2016Science Fair.
Photo: *Stanislava Kyselová*

A unique documentary film *Movements* created by *The Centre of Administration and Operations* and *The Institute of Rock Structure and Mechanics* won the Jury Award at the *51st International Academia Film Olomouc* festival of films popularizing science. It takes

viewers to the Arctic north to follow a group of geologists from *The Institute of Rock Structure and Mechanics* who arrive there every year to monitor tectonic movements of the Earth with a unique device, to study extensive rock falls and map the unexplored terrain that had previously been hidden deep under the ice. Through patient observations of the natural world around them they succeed in acquiring fundamental and so far unpredictable and surprising data about our planet Earth. The film presents not only scientists´ research work, but also themselves and their lives in the harsh environment far beyond the polar circle.



Shooting the unique documentary film *Movements – Discovering Processes Deep in the Earth´s Interior*.
Photo: Filip Hartvich, The Institute of Rock Structure and Mechanics of the CAS