

**HUNGARIAN ACADEMY OF SCIENCES**

**RESEARCH ACTIVITIES  
of the  
Institutes for natural sciences**











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The texts of this publication were prepared and  
checked by the institutes themselves.

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## PREFACE

The Hungarian Academy of Sciences has recourse to significant research potential in the field of natural sciences.

A total of some 5830 individuals—including 2240 researchers—work in 28 institutes. Within these institutes there is at least 40 per cent of Hungary's research potential in the natural sciences.

In the coming period one of the aims of our scientific policy is to build more links between the teaching and research work in the universities and the research activities of the Academy. It is our intention to encourage this process by supporting real scientific interests rather than by using administrative means. Of the Academy's researchers, at least a quarter regularly hold lectures at the universities.

Another of our strategic aims is to ensure the autonomy of the institutes of the Academy and their freedom of research. The idea underlying this is to ensure that these institutes are free to make decisions on the subjects of their research, on their internal structure, and on their links with foreign organizations.

However, the work done in the institutes and their research concepts are regularly evaluated by the scientific organizations of the Academy.

It is very much hoped that this present publication will act as a means of providing useful information to facilitate future cooperations.

István Láng

Secretary General  
Hungarian Academy of Sciences





## INSTITUTE OF MATHEMATICS

*Address:* Budapest, Reáltanoda u. 13-15.  
*Postal address:* H-1364 Budapest Pf. 127.  
*Telephone:* (36-1) 117-3151  
*Telefax:* (36-1) 117-7166  
*Director of Inst.:* András Hajnal O.M.

### Scope of activities

The principal function of the institute is to perform systematic basic research in various topics in mathematics and its applications, concentrating on theoretical studies inspired partly by the internal development of mathematics, partly by the applications of mathematics in other sciences and in social practice. Other important functions of the institute are to provide active support for the teaching of mathematics and the education of mathematicians of various levels, to participate in the post-graduate training of mathematicians working in other institutes, and to contribute to the general progress of mathematical culture. To accomplish these goals, the Institute organizes postgraduate courses, publishes textbooks, participates in postgraduate education and offers visiting research positions.

### Research aims and topics

- Set theory and set-theoretic topology
- Algebra
- Algebraic logics and computer science
- Complex analysis and number theory



The building of the institute

- Approximation theory
- Topology
- Functional analysis
- Differential equations
- Discrete mathematics
- Geometry
- Probability theory
- Mathematical statistics
- Information theory
- Statistical physics
- Operations research
- Operations research
- Operation theory
- Operations theory

## KONKOLY OBSERVATORY

*Address:* Budapest, Konkoly Thege u. 13-17.  
*Postal address:* H-1525 Budapest Pf. 67.  
*Telephone:* (36) 1-175-4122, (36) 1-175-5866  
*Telefax:* (36) 1-156-9640  
*Director of Inst.:* Béla Szeidl D. Sc. (Physics)

### Scope of activities

Carrying out observational astronomical studies, mainly related to the physics of the variable stars, galactic structure, solar activity and the terrestrial upper atmosphere. These tasks imply operation of the internationally recognized observational network developed during the last three decades. A very important task - perhaps the most important one for the future - is the further development of the national astronomical information system, including the observatory's library.

### Research aims and topics

Studies concerning the behaviour of variable stars: investigation of multiple periodicity and period changes of pulsating variables, as well as research on stellar activity of various time-scales.

Studies related to the galactic structure and physics of interstellar matter with an emphasis on the star-forming processes.

Studies of the upper atmosphere of the Earth and Mars with space-borne equipment.

Studies on solar activity, investigation of the problems of sunspots and prominences.



The main building of the Astronomical Institute (Konkoly Observatory) of the Hungarian Academy of Sciences (designed by Gyula Sváb) and János Pásztor's sculpture: "Sic itur ad astra".

### Variable stars

A better insight into the physics (mechanism of light variation, processes occurring in the stellar atmosphere) and evolutionary status of the variable stars.

### Solar physics

Research on the solar active regions, kinematics of spots, spot-groups, prominences and flares.

### Stellar statistics

Studies of galactic structure and processes



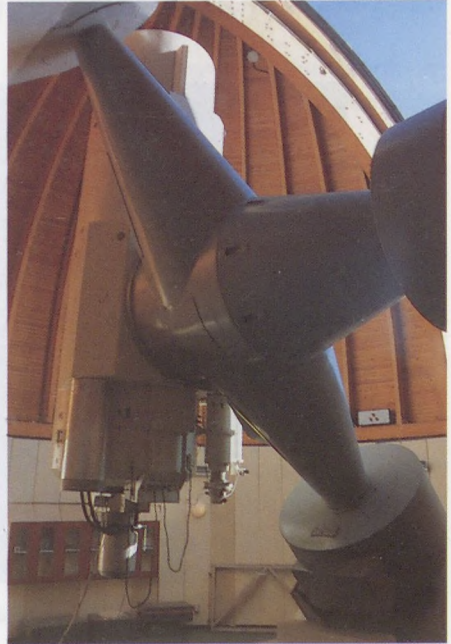
of star formation in the Milky Way, mainly from the observational point of view.

### *Upper atmosphere*

A better insight into the physical condition of planetary atmospheres (Earth, Mars), correction of the atmospheric models.

### *Miscellaneous*

Other minor topics which have been successfully studied, mainly in the fields of interdisciplinary and/or space research, in cooperation with the staff of other institutes.



The 1 m RCC (Ritchey - Chrétien - Coudé) telescope equipped with a five-colour photon-counting photometer.



## INSTITUTE OF NUCLEAR RESEARCH



The main building of the institute

*Address:* Debrecen, Bem tér 18/c

*Postal address:* H-4001 Debrecen Pf. 51.

*Telephone:* (36) 52-17-266

*Telefax:* (36) 52-16-181

*Director of Inst.:* József Pálinkás D.Sc. (Physics)

### Scope of activities

- to conduct basic and applied research in nuclear and atomic physics,
- to apply physical methods in other disciplines (materials science, earth sciences, environmental research, medical and biological research, etc.) and in practice,
- to develop research techniques and instruments,
- to contribute to graduate and postgraduate education.

### Research aims and topics

#### *Nuclear Physics*

- Spectroscopy of medium-heavy odd-odd nuclei
- Study of superdeformed nuclear states
- Reaction studies on the collective properties of nuclei of the sd shell
- Low-energy light-ion reaction experiments for nuclear spectroscopy and nuclear astrophysics

- Nuclear cluster theory
- Measurement of nuclear data for nuclear techniques

### *Atomic Physics*

- Study of electron correlation in atomic collisions
- Study of two-centre effects in atomic collisions
- Investigation of charge exchange processes
- Theoretical description of atomic collisions
- Investigation of the interaction of ions with metals, and with chemical and biological samples
- Study of collisions in extreme conditions (e.g. in strong electromagnetic fields)

### *Materials Science and Analysis*

- Study of high-temperature superconductors
- Study of the working mechanism of Si(Li) detectors
- Electron spectroscopy, mass spectroscopy and ion spectroscopy for surface physics
- Measurement of atomic properties in solid-state environments
- Applications of the activation method of materials research

### *Earth and Environmental Sciences and Archeology*

- Applications of methods of geochronology, based on the measurement of isotopic abundances, to hydrology, petrographical genetics, paleoclimatology and hydrocarbon prospecting
- Application of  $^{14}\text{C}$  dating in archeology

- Investigation of atmospheric aerosol pollution
- Investigation of gaseous pollutants of the air, including those aggravating the green-house effect
- Measurement of radioactivity in the environment and the radiation doses received by the population
- Measurement of the concentrations of anthropogenic poisonous pollutants

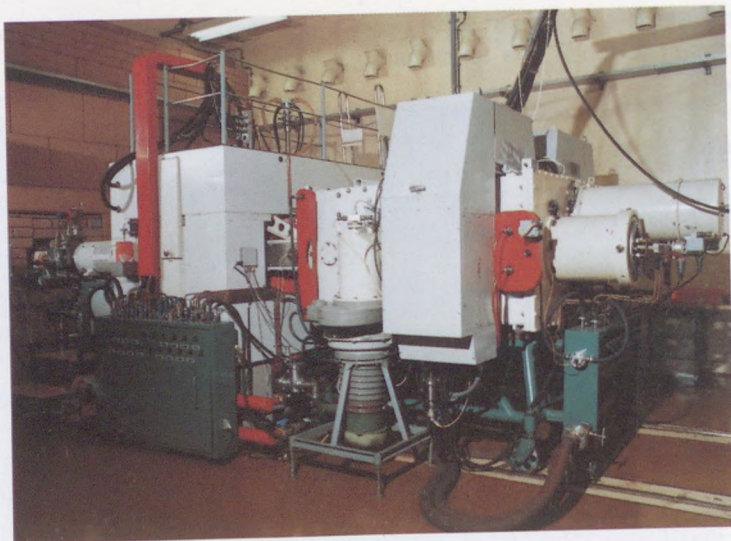
### *Applications of Nuclear Techniques in Medicine and Biology*

- Production of radioactive isotopes by a cyclotron and preparation of radiopharmaceuticals
- Application of a neutron radiation source in radiotherapy and radiobiology
- X-ray fluorescence analysis of trace element contents in biological tissues
- Mass spectrometry of the gas metabolism of plants

### *Development of Measuring Techniques and Instruments*

- Methodology of electron spectroscopy, of nuclear analytical techniques and of nuclear tracing
- Elaboration of digital signal processing and other electronic techniques
- Developments in magnetic and quadrupole mass spectrometry
- Development of electronic devices based on superconductivity
- Development of plastic track detection techniques and production of nuclear filters
- Accelerator physics and development





The MGC-20 cyclotron



## KFKI RESEARCH INSTITUTE FOR SOLID STATE PHYSICS



One of the laboratory buildings of the Research Institute. The institute is located in the beautiful surroundings of the capital.

*Address:* Budapest, Konkoly Thege u. 29-33.

*Postal address:* H-1525 Budapest Pf. 49.

*Telephone:* (36-1) 169-6575

*Telefax:* (36-1) 169-5380

*Director of Inst.:* Norbert Kroó O.M.

### Scope of activities

Basic research in specific areas of theoretical solid state physics, partially ordered condensed matter physics, metal physics and laser physics. Applied research such as laser development and applications in technology, measuring techniques and medicine, as well as the production and study of amorphous alloys. Development of unique research methods including neutron scattering, nuclear magnetic resonance, x-ray diffraction, and ultrashort laser pulses.

### Research aims and topics

#### *Theoretical study of strongly correlated systems*

- Properties of low dimensional magnetic materials
- Ground state and excited states in two dimension models
- Strongly correlated electron systems of one and two dimensions with superconducting or magnetic properties

### *Theoretical study of complex systems*

- Entropy and its generalized versions
- Cellular automata models
- Chaotic systems
- Interaction of strong electromagnetic fields with matter

### *Study of electronic states in solids*

- Determination of the electronic wave functions of given energies with the LMTO (Linear Muffin - Tin Orbital) method
- Calculation of the dielectric function and determination of the frequency dependent optical properties

### *Study of magnetic film structures by local methods*

- Application of electron paramagnetic resonance, nuclear magnetic resonance and Mössbauer effect to obtain information on the magnetic structure, defects and dynamic phenomena in isolating or superconducting magnetic sandwich structures with different atomic compositions

### *Investigations on charge and spin density wave systems*

- Study of the electric (magnetic) noise spectra for interpreting weak relaxation processes and phase transition fluctuations
- Study of the interaction of the collective mode with the optically excited charge carriers in the nonlinear region.
- Search for metastable states, magnetic memory effects as well as slow relaxation processes in spin-density-wave systems.

### *Investigations of non-equilibrium alloys*

- Study of the atomic and electronic structure as

well as magnetic properties of non-equilibrium alloys.

- Production technologies of non-equilibrium alloys and the influence of the technology on the value of the magnetic moment.
- Study of the trigonal prism structure important in the formation of different amorphous systems.
- Comparative Mössbauer-spectroscopic study of the atomic and electronic structure of amorphous systems produced by different technologies.

### *Metal research*

- Production and complex investigation of metal-hydrogen systems, with special regard to the hydrogen storing capacity, local properties and electronic structure of these alloys.
- Production and study of alloys with sandwich structures
- Development of methods for fast quenching of melted metals and alloys
- Development of non destructive material testing methods and devices
- Development of magnetic sensors for the detection of displacement and magnetic field strength.

### *Liquid crystal research*

- Production and study of ferroelectric liquid crystals
- Production and study of transient and permanent structures
- Study of nonlinear optical phenomena in liquid crystals
- Investigations on multi-component systems; study of the origin of deviations from the addition rule in liquid and solid mixtures.

### *Neutron physics research*

Basic and applied research with different



neutron physical instruments positioned at the recently reconstructed research reactor, in the following fields:

- Structural studies on amorphous metallic, Si, Ge and C samples
- Structural studies on solid or smectic type mesophases of fast quenched metallic or liquid crystalline samples
- Study of copper oxide based high T<sub>c</sub> superconductors
- Study of aqueous solution of hydrophobic organic molecules
- Study of conformational changes of biological systems
- Dynamic neutron and gamma radiography.

#### *Laser research*

- Study of the basic physical phenomena in hollow cathode excited gas lasers
- Investigation of CW ultraviolet gas lasers
- Development of miniaturized solid state lasers
- Research of lasers radiating in more than one dimension
- Study of surface electromagnetic waves (plasmons) in solids.

#### *Light-matter interactions in extreme high light fields*

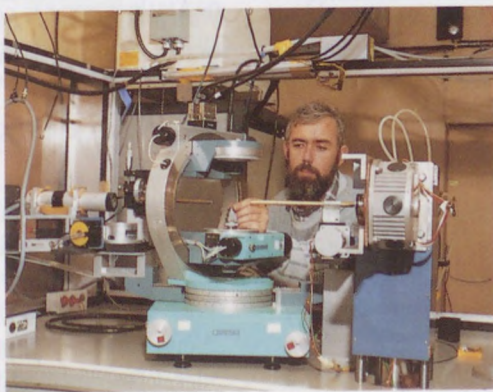
- Observation of the discrete energy spectrum of photoelectrons, predicted by theory
- Optimization of electron beams emitted by photoeffect from metal surfaces in high intensity laser fields.
- Study of light emission processes induced simultaneously with photoelectric emission in the search for new types of x-ray and UV light sources.

#### *Laser applications*

- Development of high power solid state lasers; new active materials with high efficiency, new pumping light sources, thermally stable resonators
- Production and study of "squeezed" light
- Development of non-contact laser anemometers
- Development of laser-interferometric devices and methods.

#### *Optical thin film technology*

- Development and production of new type high quality optical coatings with special attention to the ionic vacuum evaporation technique.



X-ray laboratory for diffraction measurements.



## KFKI ATOMIC ENERGY RESEARCH INSTITUTE



The main building of the institute.

*Address:* Budapest, Konkoly Thege u. 29-33.

*Postal address:* H-1525 Budapest Pf. 49.

*Telephone:* (36-1) 169-6762

*Telefax:* (36-1) 155-2530

*Director of Inst.:* János Gadó C. Sc. (Physics)

### Scope of activities

In accordance with the Hungarian law on the uses of nuclear energy, the main activities of the Institute cover basic and applied research as well as development in the fields of reactor physics, reactor diagnostics, thermohydraulics, real-time information, monitoring and surveillance systems, reactor simulation, probabilistic and deterministic assessments of reactor safety, analysis of severe accidents, radiation damage, fracture mechanics, leakage detection, radiation protection. Further tasks involve development of environmental monitoring systems; risk evaluation; methods used in analytical, chemi-

cal and physico-chemical processes and in acoustic emission; research into space electronics and aviation diagnostics; operation of a research reactor and critical assemblies.

### Research aims and topics

*Modelling of processes taking place in nuclear facilities and in the environment*

- development of new methods and procedures in reactor physics,
- development of special methods and tools for reactor safety evaluation,

- reactor physics calculations for normal operation,
- modelling of situations leading to reactivity accidents,
- evaluation of the efficiencies of safety system,
- investigation of core cooling effects of non-condensable gases,
- modelling of accident processes,
- modelling of severe accidents leading to core melt,
- questions of transportation and storage of spent fuel,
- modelling of environmental risks.

#### *Expert systems and operator aiding systems*

- development of systems controlling the core in nuclear power plants,
- development of operator monitoring and surveillance systems for nuclear power plants,
- development of learning algorithms for model improvement and prediction,
- development of expert systems in acoustic diagnostics,
- development of diagnostic methods, new numerical procedures and physical models.

#### *Evaluation of safety of nuclear power plants*

The main goal is the reassessment of the safety of the Paks NPP.

The processes investigated are:

- events leading to reactivity accidents,
- events with or without loss of coolant,
- core melt processes.

#### *Accident management methods*

Methods developed are aimed at helping to prevent the development of low probability processes leading to severe consequences, or at least to mitigate the consequences.

#### *Development of training simulators*

Accidents at nuclear power plants generally arise from human errors rather than from constructional errors or mechanical failure. Consequently, in addition to a high level of automation, the proper training of a power plant's operators is of crucial importance. The training simulator is the best tool to fulfil this task.

#### *Aging of equipment at nuclear power stations*

- development of methods for investigating radiation damage and aging,
- improvement of codes investigating radiation damage and aging,
- construction of a data bank and evaluation of international data on aging.

Research activities in this field are concentrated on:

- simulation of initial phases of the conditions leading to core damage,
- simulation of severe accidents,
- parallel processing of simulation algorithms,
- development of graphic communication languages, and intelligent and interactive workstations.

#### *Safety of hazardous industrial equipments*

Knowledge accumulated during investigations of nuclear safety can well be applied to answering questions relating to other hazardous industrial activities. The methods and devices that can be employed in other fields are, for example:

- probabilistic analysis,
- industrial diagnostic systems,
- application of simulators.



### *Environmental protection*

The goal of this research is to develop environmental monitoring systems that match international European standards and to solve several nuclear and non-nuclear problems:

- reconstruction of the telemetric radiation monitoring system around the Paks Nuclear Power Plant,
- development of a national environmental monitoring system,
- investigation of certain elements and parameters of the ecological chain,
- localization of radio-isotopes in the soil,
- updating of a mobile laboratory used for radiation protection,
- investigation of the emission and environmental effects of aerosols.

### *Special electronic devices*

Development of electronic measuring instruments for use in space research. This work is strongly based on experience gained during the development of special-purpose reactor electronics.

### *Health physics research*

This research is carried out in order to understand the basic processes in health physics and to provide theoretical support for radiation protection. It involves:

- construction of a stochastic lung model,
- modelling of transport processes,
- improvement of solid-state dosimetry,
- development of new thermoluminescent readers for space dosimetry.

### *Physico-chemical research*

The goal is to explore the spatial/temporal correlations in the structure of condensed matter and to try to understand the relationships between certain physico-chemical processes. The main tasks are:

- investigation of the dynamics of processes taking place on electrodes of fractal surfaces,
- determination of kinetic laws of transport processes,
- electrochemical determination of corrosion processes,
- investigation of isotope mixtures.

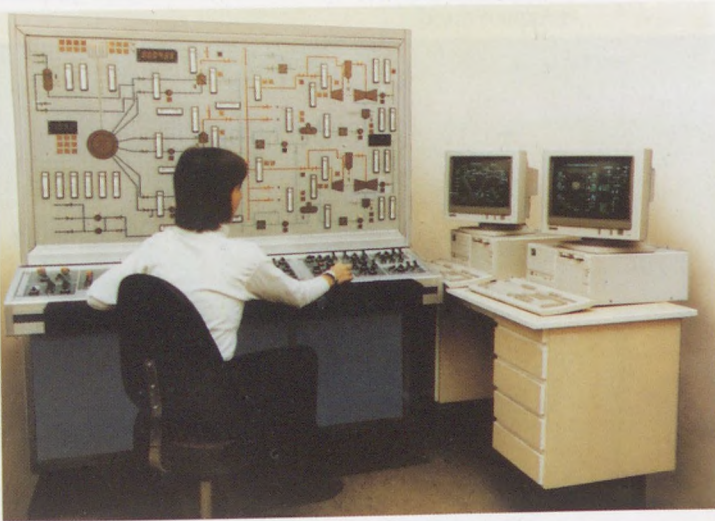
### *Research into and applications of chemical analysis*

Analytical methods and measurement processes developed during the course of the various research projects are subject to continuous improvement. The development of processes utilized in environmental protection and in severe accident investigations is an important part of our work. The third main field of applications is neutron activation analysis utilizing the research reactor.

### *Utilization of the reactor for research and other fields*

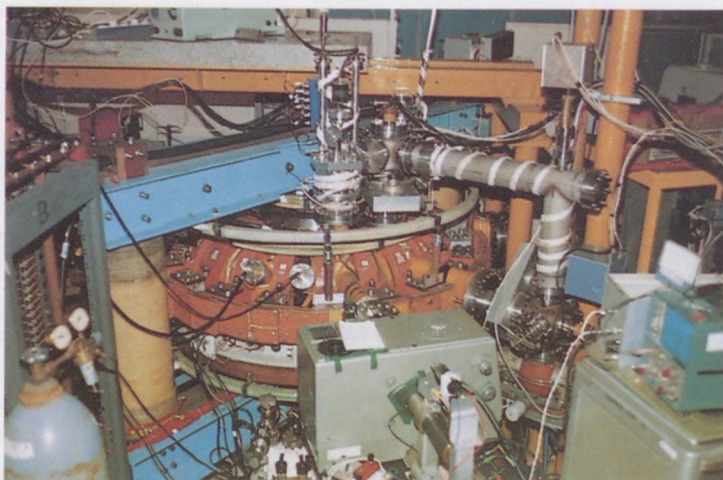
If the reactor becomes operational, 1500 hours of operation at a power of 10 MW can be expected from 1993 onwards. It is envisaged that there will be a number of fields of application: isotope production, silicon doping, activation analysis, neutron radiography.





Basic principle simulator developed for Paks Nuclear Power Plant

## KFKI RESEARCH INSTITUTE FOR PARTICLE AND NUCLEAR PHYSICS



Tokamak device for plasma physics experiments

*Address:* Budapest, Konkoly Thege u. 29-33.

*Postal address:* H-1525 Budapest Pf. 49.

*Telephone:* (36-1) 155-1682

*Telefax:* (36-1) 169-6567

*Director of Inst.:* Károly Szegő D. Sc. (Physics)

### Scope of activities

Fundamental research in nuclear physics, plasma physics, particle physics, space physics, theoretical research, materials science and biophysics. Applied research and development in the field of laser techniques, nuclear analytics, space electronics, fast data processing, and optical and X-ray spectroscopy. The provision of services utilizing our basic research equipment is an integral part of our activity. Most of the institute's work is connected with the so called „big sciences”, which are realized within the framework of international cooperation.

### Research aims and topics

#### *Experimental nuclear physics*

- in the field of high energy nuclear physics: investigation of relativistic heavy ion collisions
- in the field of low energy nuclear physics: study of the mechanism of the coupled direct reactions induced by  $^3\text{He}$  particles and that of the structure of the participating nuclei
- cooperation in the heavy ion research at CERN, mainly by developing and manufacturing detectors.



### *Thermonuclear plasmaphysics and laser physics*

Continuing the research activity that started in 1975, the institute envisages cooperation in various research projects of the European Communities.

Research subjects:

- investigation of the formation of magnetic islands in hot plasmas by tomography
- investigation of particle transport in tokamak plasma, study and development of plasma radiation detectors for observing plasma processes by tomography
- infra-red laser research and development for plasma-physical experiments; investigation of laser plasmas.

### *Experimental particle physics*

Hungary became a member of CERN and this opened new prospects for Hungarian particle physics. In the next few years Hungary will need to make great efforts in order to set up an appropriate infrastructure enabling it to take advantage of this unique opportunity.

- Concentration on research into „Higgs physics” and „quark-gluon plasma in heavy ion collisions” at CERN's LEP, LHC and SPS accelerators is considered to be of prime importance.

### *Space physics*

- Development of on-board devices and ground support equipment for the Russian Mars-94/96 space mission, and of ground support equipment and on-board software for scientific experiments relating to the NASA CASSINI mission.
- In space electronics: development and manufacture of long-life, high reliability, fault-

tolerant (self-correcting) devices and on-board computers.

- Scientific interpretation of the data of the VEGA and Phobos space missions in international cooperation.

### *Theoretical research*

- Connection between the general theory of relativity and gravity and the classical field theory.
- Dynamics of many-particle quantum systems.
- Investigation of ultra-relativistic heavy ion reactions.
- Field-theoretic study of elementary interactions.

### *Materials science*

- Utilization of nuclear physics to investigate the structure of materials (superconductors, low-dimension magnetic systems, insulators, solid phase amorphous and ordered alloys, lattice defects, semiconductors and layers heavily implanted with noble gases)
- Setting up research conditions based on the institute's accelerators to study surface and near-surface layers, and to investigate the hyperfine interactions and defect structure of these layers using conversion electron Mössbauer spectroscopy and low (a few keV) energy electrons and positrons.

### *Neurobiology and nuclear biophysics*

The strategy for this area is based on the recognition of the growing importance of using physical methods. The two main research topics are:





Van de Graaff type particle accelerator

Theoretical investigation of the dynamic organization of semantic memory, of the neurodynamics of visual illusions, and of olfactory coding and memory.

- Study of the concentration, distribution and binding of essential (or toxic) trace elements in proteins and enzymes in order to clarify their structure and function by combining special nuclear analytical techniques with biomechanical separation processes.

## KFKI RESEARCH INSTITUTE FOR MATERIAL SCIENCE



Central research building

*Address:* Budapest, Konkoly Thege u. 29-33.

*Postal address:* H-1525 Budapest Pf. 49.

*Telephone:* (36-1) 169-5165

*Telefax:* (36-1) 155-0694

*Director of Inst.:* József Gyulai C.M.

### Scope of activities

Basic and applied research in the field of atomic phenomena related to ion implantation, formation of lattice defects (characteristic features and interactions), formation mechanism of thin solid films and surfaces, magnetic and magnetooptic features of amorphous and crystalline materials and mass transport by diffusion; research and development in the field of fabrication of shallow p-n junctions, laser-light-assisted deposition and ablation of material as well as of the growth of doped oxide single crystals; development in the field of ellipsometry,

tunnel microscopy, ion sources, analytics in the protection of environment, laser-assisted semiconductor technology and computer control.

### Research aims and topics

#### *Implantation research*

- preparation of implanted structures
- application of defect-dynamic methods
- multiple implantation
- photon-assisted implantation
- thermal annealing



*Magnetic research*

- study of magnetic processes, recovering coherence of material structures
- features of material structures
- features of garnet epitaxial film
- properties and structure of metallic glasses
- nanocrystalline materials, multilayers, nanocomposites

*Thin film research*

- preparation and investigation of semiconductor, metallic and optical thin layers
- layer deposition in ultrahigh vacuum, ion-assisted methods
- high T<sub>c</sub> superconductor films
- molecular beam epitaxy
- laser-assisted evaporation and CVD

*Nanotechnology research*

- preparation and characterization of nanostructures
- investigation of system parameters
- criteria of stability
- mezosopic and multilayer systems

*Research of semiconductor devices (for educational purposes)*

- technology research: shallow p-n junctions, metal-semiconductor reactions, methods for contrast enhancement
- device-oriented research: gas sensors, microelectrodes, anisotropic etching

*Research of crystal growth (for educational purposes)*

- investigation of effect of optically active impurities and growth parameters
- properties of GGG crystals
- preparation and investigation of crystals with new composition
- epitaxial film growth with extremely thick and sandwich structures

*Other research*

- application of chemical analysis in environmental protection
- basic phenomena in optics
- computer-aided ECG research
- solid state research and modelling



LACVD; a laboratory for laser-assisted CVD equipment



## KFKI RESEARCH INSTITUTE FOR MEASUREMENT AND COMPUTING TECHNIQUES



Headquarter of the Institute

*Address:* Budapest, XII. Konkoly Thege u. 29-33.

*Postal address:* H-1525 Budapest Pf. 49.

*Telephone:* (36-1) 169-9499

*Telefax:* (36-1) 169-5532

*Director of Inst.:* Ferenc Vajda D. Sc. (Engineering)

### Scope of activities

The main goals of the Institute are application oriented basic research and development of methods and tools in the fields of computing, information technology and measurement. The most important fields of activity are as follows: Parallel architectures and algorithms, software and applications in parallel architecture machines, image processing, algorithm oriented architectures, object oriented simulation systems; methods and tools for laboratory instrumentation and measuring methods, especially for experiments in physics, nuclear physics and biology; modelling, instrumentation and meas-

uring techniques for large industrial systems, e.g. power distribution; formal methods in data communication network protocol testing and verification.

### Research aims and topics

#### *Computer architectures and algorithms*

- Special computer architectures
- Parallel computing techniques
- Special algorithms
- Applications, hardware and software tools.

*Image processing*

- New architectures
- Image databases
- Image processing languages
- Applications (quality control, computer assisted microscopy, etc.).

*Real-time measurement and automation*

- Measuring methods and computerized real-time systems
- Applications for scientific experiments (measurement automation in nuclear, physical, chemical, biological, medical laboratories).

*Modelling of technological systems*

- Model building methods and applications for complex technologies

- Automation, simulation and training in the related application fields, specially in energy generation, transfer and distribution.

*Simulation techniques*

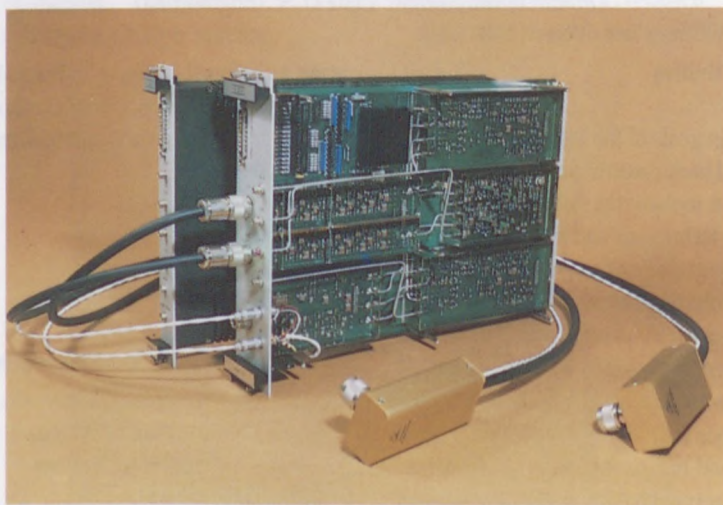
- Object oriented simulation methods.

*Data communication protocols*

- Methods for evaluating data communication protocols
- Protocol testing
- Formal description of protocols.

*Miscellaneous*

- Speech technology and processing
- Data compression techniques.



Beam Position Monitor Electronics for COSY Accelerator



## COMPUTER AND AUTOMATION RESEARCH INSTITUTE

*Address:* Budapest, Kende u. 13-17.

*Postal address:* H-1502 Budapest, Pf. 63.

*Telephone:* (36-1) 166-5644

*Telefax:* (36-1) 166-7503

*Director of Inst.:* László Keviczky C.M.

### Scope of activities

- Research in computer science and automation.
- Tasks deriving from the principal research direction of the Hungarian Academy of Sciences: „Applications of Computer Science”.
- Management and supervision of the central computer of the Academy as a support to research.

Based on the above, the research objectives of the Computer and Automation Research Institute are: performing basic and applied research in the field of intelligent systems, developing pilot and reference systems with the help of different tools and methods of informatics.

### Research aims and topics

#### INTELLIGENT ENGINEERING SYSTEMS AND APPLICATIONS

##### *Artificial intelligence and expert systems*

- New directions in expert systems, cognitive processes
- Computer-aided translation and understanding



The building of the (Computer and Automation Research) Institute (of the Hungarian Academy of Sciences,) situated in Budapest, Kende street.

- Application of artificial intelligence methods in mechanical engineering
- Formal models of distributed co-operative systems

##### *Intelligent control*

- Research of intelligent signal-processing and pattern recognition systems
- Knowledge representation methods of intelligent control and diagnostics of technological processes
- Special processing techniques in control theory

*Intelligent sensing and robot-control*

- Digital picture analysis, computer vision, pattern recognition
- Sensor-based control

**RESEARCH OF NEW COMPUTATIONAL STRUCTURES***Dual and neural networks*

- Theory of cellular neural networks (CNN)
- Dual computing architectures
- Neural computing algorithms in biological and cognitive models

**RESEARCH IN INFORMATICS AND COMPUTER SCIENCE***Informatics*

- Fundamental models related to data-bases
- Mathematical analysis of data structures
- Multimedia systems
- New trends in visual man-machine interfaces
- Distributed object management
- Object-oriented development environment (New Wave)

*Theoretical computer science*

- Algebraic algorithms
- Multivalued logics
- Multi-dimensional discrete mathematics, multi-variable analysis

*Mathematical research related to computer applications*

- Analysis of nonlinear differential equations
- Graphs and networks

*Decision support systems*

- Decision-making and expert systems
- Operations research and optimization

**INTEGRATED DESIGN AND CONTROL SYSTEMS***Intelligent design methods of integrated manufacturing systems*

- Computer-aided design and production automation
- Power systems and energy converters
- Design of technological processes and databases

**RESEARCH IN INFORMATION INFRASTRUCTURE***Computer networks*

- Electronic telephone directory
- INTERNET computer network communication technology
- ISDN network technology
- New technologies in network supervision
- Analysis of UNIX-based computer networks

*Office automation, electronic document handling*





Computer model of a car-body panel

## RESEARCH INSTITUTE FOR TECHNICAL PHYSICS

Address: Budapest, Fóti u. 56.  
 Postal address: H-1325 Budapest, Újpest 1. Pf. 76.  
 Telephone : (36-1) 169-2100  
 Telefax: (36-1) 169-8037  
 Director of Inst.: László Bartha D. Sc. (Chemistry)

### Scope of activities

Basic research in the field of semiconductor physics and in the field of materials science. Examination of A(III)B(V) type compound semiconductors, refractory metals, advanced ceramics, disperse and thin layer systems, investigation of materials science background for development of technology, coherent and incoherent light sources, microwave devices, layer structures, production of power metallurgical and ceramic samples, development of environment-protecting chemical technologies, investigation of material testing methods.

### Research aims and topics

Investigation of dispersion hardened refractory alloys. The aim of this research is to form an optimum texture for high temperatures, to achieve high quality control in manufacturing:

- refractory metals hardened by soft phases (tungsten-, molybdenum-potassium systems).

### Advanced ceramics

Silicon nitride based ceramics, manufacturing, investigation of sintering processes:



The view of the institute

- modelling of solid skeleton of ceramics
- research of structure and solid state reactions in the formation of oxide-ceramics.

### Surface and thin layer physics

#### Research of

- boundary layers
- solid state reactions at surfaces and in thin layers
- nano-layers and layer systems
- role of doping and contamination of the corrosion in growing crystalline and polycrystalline thin layers.



### *Research of new phenomena in semiconductors*

#### *In the field of*

- injection laser physics
- A(III)B(V) type semiconductor epitaxial layer structures
- interaction of laser diodes and external resonators.

### *Fractal research*

Connection between growth processes and the structure and texture.

Research of environment-protecting technologies for metal separation.

Solution, oxidation, electrodialysis and extraction of refractory metals:

- metal separation with membranes and extractions
- new methods for solution and oxidation of metals.

### *Development of new A(III)B(V) layer structures*

#### *Research of*

- GaAs and its related compounds
- new materials and structures for laser diodes
- crystal growth processes and development of equipment
- growth of GaAs from vapour phase
- heat treatment of metal contacts at compound
- semiconductors and non conducting material structures.

### *Research of semiconductor devices*

- new methods for controlling devices
- technological development of GaAs type devices
- interaction between materials and high power microwave signals

- development of fast optical switches
- construction and examination of integrated optical structures by means of the microwave properties of A(III)B(V) type semiconductors.

### *Structure research and development of microanalytical methods*

- high resolution and analytical electron microscopy
- structural and compositional measurement methods for local analysis.

### *Development of measurement techniques for optical fibres*

- examination of monomode optical fibres.



Self constructed dilatometer for creep examinations

## INSTITUTE OF ISOTOPES



Partial view of the Institute of Isotopes

*Address:* Budapest, Konkoly Thege u. 29-33.

*Postal address:* H-1525 Budapest Pf. 77.

*Telephone:* (36-1) 169-8566, (36-1) 169-6687

*Telefax:* (36-1) 156-5045

*Director of Inst.:* László Zsinka C.Sc. (Chemistry)

### Scope of activities

Investigations in the field of chemistry (radio- and physical chemistry), physics (nuclear, radiation and photophysics), medical/clinical biology (immunological, clinical and pharmaceutical chemistry): the study of organic and function-specific molecules and antibodies for in vivo nuclear medicine, as well as research and development in isotope and radiation techniques and technology.

Monitoring and prognosis of the role radioactive isotopes play in the environment and in

industry, their utilization and effects, supplemented by research and development.

Research and development in applied metrology and technology. National accountability of radioactive and fissionable materials, and their control, in the capacity of a national authority.

The Institute plays a central role in developing isotope diagnostics and in the development and introduction of alternative immunoanalytical methods, in solving problems in radiation chemistry, catalysis and low energy nuclear physics, as well as thermoluminescence. The



Institute plays a similar role in the scientific, industrial and other uses of radioactive tracers and in isotope and radiation technology.

### Research aims and topics

#### *Nuclear physics, reactor technology*

Basic nuclear research aims at solving up-to-date problems in the framework of wide international cooperation. A brand new direction will be the study of nuclear reactions with cold neutrons.

In reactor technology the Institute concentrates on questions of normal and extraordinary reactor operation, decontamination of facilities in the primary circuit, and catalytic processes taking place in nuclear reactors.

- Electromagnetic excitation of nuclei and the spectroscopy of their low-energy states
- Nuclear physical investigations on nuclei with an important role in nuclear astrophysics
- Research of nuclear reactions excited by cold neutrons
- Analysis of processes taking place during serious reactor accidents with particular attention to the emission of aerosols and radioiodine compounds
- Non-destructive testing of reactor fuel elements
- Development of an electrochemical moving-cathode decontamination technology for safe and low-waste decontamination of facilities in the primary circuits of power reactors

#### *Materials research*

Defects in monocrystals will be studied with techniques introduced and developed in the Institute in order to follow and reveal thermo-

luminescence effects. Thermoluminescence will also be used for dating purposes.

- Prompt gamma neutron activation analysis (PGNAA)
- Fundamental research into thermoluminescence
- Study of relaxation processes
- Thermoluminescent dating applied to materials of archaeological and geological origin

#### *Research in surface science and catalysis*

The main goal is to study the changes in surface structure of a catalytic system during preparation and catalytic reaction under dynamic, preferably in situ, conditions. Surface movement can be investigated by means of scanning tunneling microscope as well as quantum chemical approach.

Research is focused on three specific fields:

- Model catalysis, mono- and bimetallic catalysis, promoter effect
- Vibrational spectroscopy on surfaces
- Study of kinetics and mechanism of adsorption of organic halides on solid surfaces.

#### *Research on chemical reactions and transport processes*

Reaction mechanisms will be pursued with the help of the radioactive tracer technique as well as by using radiation and chemical kinetics. Correlation will be studied between the mechanism of complex catalytic reaction, selectivity, catalyst composition and adsorbability under reaction conditions. The detailed programme includes:

- Investigation of the mechanism of complex catalytic reaction
- Research on hydrogen transfer and alkylation
- Kinetics of radiation chemistry
- Continuous monitoring of the tritium content of air and its behaviour in the environment.

*Investigation of processes in and research methods for biological systems*

Topics to be dealt with include:

- Radioisotope and alternative immunoanalytical methods
- Interactions between antibody and antigen
- Production of antibodies, labelled peptides, nucleotides, etc.
- Metabolic (arachidonic acid, C1) investigations
- Study of the function of human organs by means of radioisotope tracing.

Based on successful preliminary investigations, steps in changes taking place in biologically active materials in natural conditions will be followed and modelled with electron pulse radiolysis. In the next few years the redox properties of intermediates will remain in the focus of attention.

Basic processes in biological systems will be studied with the practical purpose of their use in immunoanalysis and human biology.

- Study of mechanism and change of endogenous and xenogenous bioactive materials

with radioisotope and radiation chemical methods

- Immunoanalytical investigations
- Study of the chemical behaviour and possibilities of medical and biological use of molecules labelled with  $^{99m}\text{Tc}$  and other radioisotopes

*Research and development in isotope and radiation technology*

- Safe handling of radioactive materials, construction of laboratory, pilot plant and commercial radiation facilities and plants, production of radioactive sources, use of open and sealed isotopes for industry
- Dosimetry of high-intensity radiation fields, dose control of radiation processes
- Development of high-activity radiation sources for medical diagnosis and therapy, as well as process control
- Development of a computer programme system for the design of nuclear measurement units



ESCA facility



## Natural Science Research Laboratories (TTKL)

### TTKL RESEARCH LABORATORY FOR CRYSTAL PHYSICS

*Address:* Budapest, Budaörsi u. 45.

*Postal address:* H-1502 Budapest, Pf. 132.

*Telephone:* (36-1) 185-1784

*Telefax:* (36-1) 185-1158

*Director of Inst.:* József Janszky D. Sc. (Physics)

#### Scope of activities

Elaboration and development of material preparation, purification and crystal growth technologies for optical single crystals; investigation of the effect of crystal preparation parameters on defect structure; research in the field of crystal growth theory; investigation of the relationship between defect structure and physicochemical properties of crystals; non-linear optical studies; preparation of single crystals of new materials required by recent applications.

#### Research aims and topics

*Preparation and investigation of optical single crystals*

- Preparation and investigation of new optical crystals with superior parameters such as the borates  $\beta$ - $\text{BaB}_2\text{O}_4$  and  $\text{LiB}_3\text{O}_5$  for non-linear optical and  $\text{Li}_2\text{B}_4\text{O}_7$  for surface acoustic wave applications, and the photorefractive bismuth oxides  $\text{Bi}_2\text{TeO}_5$ ,  $\text{Bi}_{12}\text{SiO}_{20}$ ,  $\text{Bi}_{12}\text{GeO}_{20}$  and  $\text{Bi}_{12}\text{TiO}_{20}$ .



The view of the Natural Science Research Laboratories (TTKL) where four laboratories are situated.

- Device-oriented technological research, based on earlier results, to meet special quality requirements for routinely grown optical crystals such as  $\text{TeO}_2$ ,  $\text{LiNbO}_3$ ,  $\text{Bi}_4\text{Ge}_3\text{O}_{12}$ ,  $\text{ZnWO}_4$ ,  $\text{LiF}$ ,  $\text{NaF}$  and  $\text{KCl}$ .
- Investigation of the real structure and physical properties of crystals. In particular, studies of the effect of dopants and growth-induced real structure on the photorefractive, photochromic, paramagnetic, dielectric, spectroscopic, mechanical, etc. properties.

- Non-linear optical studies concentrated on the properties of light with special statistics, called the squeezed state and produced in

non-linear crystals, aimed at a deeper understanding of non-linear processes having perspective applications.



Set of optical crystals grown in the Research Laboratory for Crystal Physics  
from left to right:  $\text{TeO}_2$ ,  $\text{LiNbO}_3$ ,  $\text{LiNbO}_3\text{:Mg}$ ,  $\text{ZnWO}_4$ ,  $\text{Bi}_4\text{Ge}_3\text{O}_{12}$ ,  $\text{Bi}_{12}\text{SiO}_{20}$  and  $\text{Bi}_{12}\text{GeO}_{20}$   
for side:  $\beta\text{-BaB}_2\text{O}_4$  and  $\text{Bi}_{12}\text{TiO}_{20}$



## TTKL RESEARCH LABORATORY FOR INORGANIC CHEMISTRY

*Address:* Budapest, Budaörsi u. 45.

*Postal address:* H-1502 Budapest, Pf. 132.

*Telephone:* (36-1) 185-3772

*Telefax:* (36-1) 185-1158

*Director of Inst.:* Tamás Székely D. Sc. (Chemistry)

### Scope of activities

Research activities on structural inorganic chemistry, and on special fields of solid state-, macromolecular-, electrochemistry and corrosion. The Laboratory is the main body in the country responsible for any research activities in the following complex fields:

- Inorganic covalent compounds, especially their polymers.
- Electrochemistry.
- Inorganic solid state chemistry.

### Research aims and topics

*Research on silicates, inorganic polymers and special macromolecular systems*

Main fields of research: effects of intermolecular interactions on thermal decomposition and oxidation reactions of polysiloxanes and other organic and inorganic molecules. Research activities relating biomasses and various environmental problems utilizing the unique equipment and skills available in the Laboratory.

Main activities:

- Effects of inter- and intramolecular interactions on thermal decomposition reactions of substituted silane copolymers.

- Preparation and structural analysis of organic and inorganic copolymers.
- Thermal, oxidation and hydrothermal reactions of various sorts of biomass and biomass related materials.
- Oxidation decomposition reactions of lignocellulose.
- Studies in generation pathways of harmful aromatic compounds in the environment through high temperature reactions.
- Preparation of capillary columns for gas chromatography using liquid crystals and other special materials as stationary phases.
- Mathematical modelling and kinetic evaluation methods in thermal analysis.

*Research on electrochemistry and corrosion*

Novel theoretical and practical characterization of various electrochemical and corrosion processes by analysing the noise spectra to find time constants for the constituent reactions. Development and characterization of anticorrosion protection methods; research activities in electroanalytical methods to satisfy the needs of modern industry.

Main activities:

- Studies in mechanisms of electrode processes through noise analyses.
- Studies in mechanisms of electrode and corrosion processes through investigation of time constants in constituent reactions.
- Determination of metals in very low concentration by electroanalytical methods in biological matrices.

*Structure of inorganic solid state substances  
and kinetics of their reaction*

Preparation of special ceramics (powders and inorganic coatings) by thermal and plasma chemistry. The Laboratory's results have been highly valued by the international scientific community in the discipline of „surface engineering“. Studies of the surfaces by XPS and related techniques. Development of surface characterization methods.

Main activities:

- Studies of modifying processes in surface layers through determination of composition and structure.
- Preparation of powders of high dispersion for structural ceramics by plasma chemistry; studies of the main processes.
- Characterization of reactivities of oxide surfaces; studies of their gas—solid reactions.
- Relationship between atomic (electron) structure and catalytic activity of certain metal oxides.



The X-ray Photoelectron Spectroscopy (XPS or ESCA) laboratory dedicated to surface chemical and structure investigations



## TTKL RESEARCH LABORATORY FOR BIOPHYSICS

*Address:* Budapest, Puskin u. 9.

*Postal address:* H-1444 Budapest, Pf. 263.

*Telephone:* (36-1) 118-6261

*Telefax:* (36-1) 118-7480

*Director of Inst.:* Györgyi Rontó D. Sc. (Biology)

T7-phages (as chromosome models) induced by different ionic milieu

- Experimental and theoretical investigation of the structure and physical properties of simple model membranes
- Use of functional groups as spectroscopic monitors to study macromolecular structures like enzymes.

### Scope of activities

Investigation of the relationship between structure and function as well as of their changes induced by various physical and chemical agents in biological macromolecular systems.

### Research aims and topics

#### *Investigation of the structure of macromolecular systems*

Our aim is to study the conformational and electronic state of biological systems such as nucleoproteins/bacteriophages, biological and model membranes and their, protein components. Current topics:

- Kinetic investigation of structural changes in

### *Environmental biophysics*

Studies have been conducted in order to clarify the biological effects and mechanisms of action of ultraviolet radiation, as well as of some chemicals and drugs as factors influencing the state of the biosphere. Because these physical/chemical agents very often act as environmental pollution, the main goals of the research in this field are characterize their doses, and predict their biological hazards. This research includes:

- Quantitative characterization of toxic and genotoxic compounds through their biological effects, i.e. chemical dosimetry
- Characterization of the effectiveness and mechanisms of action of substances influencing the functions of biological membranes
- Measurement of the biological effects of ultraviolet radiations (UV A and B).



Apparatus for automatic determination of the phage-bacterium interaction parameters constructed and manufactured in Research Laboratory for Biophysics



## TTKL LABORATORY FOR GEOCHEMICAL RESEARCH

*Address:* Budapest, Budaörsi u. 45.

*Postal address:* H-1502 Budapest, Pf. 132.

*Telephone:* (36-1) 185-1781

*Telefax:* (36-1) 185-1158

*Director of Inst.:* György Pantó C.M.

### Scope of activities

Basic research in the fields of petrogeneses, formation of mineral deposits and of environmental geochemistry. Special attention is paid to the complex geochemical-petrological processes related to the formation of the mineral raw materials of Hungary, to the factors determining their accumulation and in supporting the many-sided utilization. Investigation of the geochemical processes taking place in the geospheres and their boundaries ensures the basis for the special trends of environmental research.

### Research aims and topics

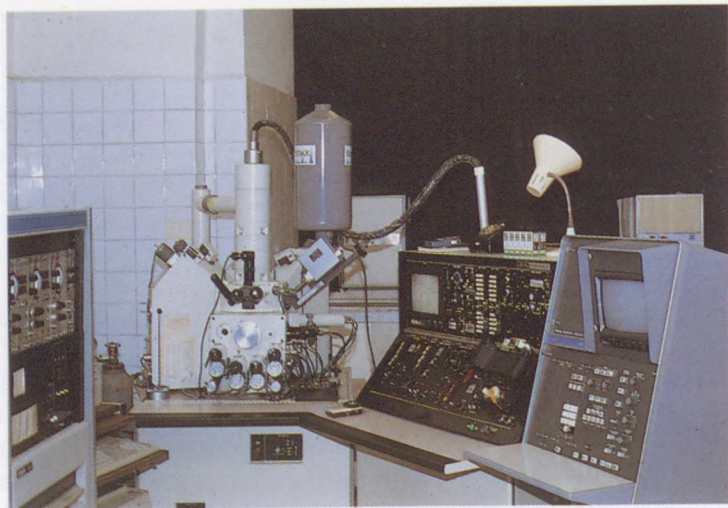
Taking into consideration the advantages of continuity in activities, the research aims are based on the methods and topics which have successfully been applied and elaborated in the

last few years. The Laboratory intends to improve its activities in fields which derive from the inherent necessity of the development of geosciences in Hungary and to initiate new research fields either in a methodological or in a regional context.

This research is to be realized in the following scientific fields: geochemistry of the processes of mineral- and petrogenesis, theoretical and methodological research related to energy-producing and other mineral resources and the introduction of promising topics, and the improvement of traditional research.

*The research topics are as follows:*

- Mineralogy, petrology and geochemistry of the processes of sedimentary and metamorphic rock formation;
- Geochemistry of fossil fuels (petroleum, coal), (extensive knowledge of their genesis enables one to promote their exploration as a means of improving their many-sided utilization);
- Geochemistry of igneous processes and the isotope geochemical investigation of geological problems in Hungary;
- Research of the geochemical state of Hungary, primarily to determine the extent of supply of bioessential elements.



Superprobe 733  
Electron Probe X-ray Microanalyzer



## CENTRAL RESEARCH INSTITUTE FOR CHEMISTRY



1. Partial view of the institute

*Address:* Budapest, Pusztaszeri u. 59-67.

*Postal address:* H-1525 Budapest Pf. 17.

*Telephone:* (36-1) 135-3735, (36-1) 115-2868

*Telefax:* (36-1) 135-2112

*Director of Inst.:* Ferenc Márta O.M.

### Scope of activities

Investigations (primarily basic research) conducted on essential topics of chemistry and related areas requiring coordinated operation of extensive research capacities and major up-to-date equipment.

Strategic research related to domestic industrial branches of the chemical industry, agricultural and food industries, as well as public health and environmental protection, based mainly on the results of basic research.

Contribution to higher education and postgraduate training under the Athenaeum Program. The Institute is able to offer a considerable

contribution mainly in the last stage of graduate training, and in postgraduate education.

Development of the basis of new technologies, as well as production of materials and servicing activities.

### Research aims and topics

In the period 1991-1995, the main objective of the Central Research Institute for Chemistry is to establish coordination between scientific investigations revealing novel information and strategic research based on the knowledge acquired, as well as R+D activities carried out under contracts.

### *Organic and Bio-organic Chemical Research*

The primary aim of organic and bio-organic chemical investigations is to establish basic rules of correlation between chemical structure and biological effect. The experiments in view cover the following activities: synthesis of novel organic compounds, quantitative analysis and theoretical interpretation of organic and bio-organic processes.

- Bio-organic chemical research of nucleosides, nucleotides and nucleic acids
- Research and development of chemotherapeutic substances
- Synthesis of radioactive labelled compounds
- Synthesis of heteroaromatic systems (containing bridgehead nitrogen atoms) for studying their reactivity and biological effect
- Synthesis and study of physiologically significant carbohydrate derivatives with nitrogen, sulphur, and phosphorus content
- Synthesis of natural organic compounds
- Investigations in molecular pharmacology
- Preparation and study of pharmaceutical compounds bound to polymers
- Study of biopolymers of plant origin and their metal complexes.
- Chemistry and biochemistry of herbicidally active compounds (herbicide safeners) and their precursors.

### *Physicochemical and Macromolecular Chemical Research*

Physicochemical investigations involve the study of adsorption, homogeneous- and heterogeneous catalysis, reaction kinetics, photochemistry, as well as electrochemistry, liquid structure and corrosion. In the Department of Macromolecular Chemical Research synthesis and study of the degradation of polymers, as well as physicochemical investigations on the

structure and properties of complex polymer systems are envisaged.

- Study of the mechanism of catalytic and redox reactions and application in organic chemistry
- Modelling the mode of action of photosensitizers, which play a role in chemical and biological systems
- The role of free radical reactions in liquid phase oxidative processes of hydrocarbons
- Research providing the basis of chemical technologies
- Study of the formation and extinction of singlet molecular oxygen atoms
- Study of heterogeneous catalytic transformation of organic compounds on oxide-type catalysts, mainly zeolite; research facilitating the preparation of adsorbents, catalysts, carrier- and filling materials from domestic silicate minerals, mainly zeolite-containing rocks
- Study of the structure and crystal chemical properties of clay minerals and zeolites
- Planning catalysts and immobilized systems; elucidation of the correlation between production, structure and mode of action
- Photochemical-kinetic investigation of elementary reactions for the purpose of elaborating material and energy saving procedures
- Liquid structure investigation by x-ray diffraction
- Study of the mode of action of inhibitors
- Electrocatalytic and electrosorption investigations
- Study of the adsorption of metals on the surface of other metals
- Study of the laws of radical polymerization and/or copolymerization from theoretical and practical aspects in essential monomer systems
- Preparation and study of environmentally benign polycondensates (polymers) for environmental protection purposes



- Preparation of homo- and copolymer systems containing reactive end-groups by means of radical copolymerization
- Study of the correlation between structure and stability in the case of polymers, copolymers and polymer alloys
- Structure investigations and modification of polymers and complex polymer systems as well as elucidation of structure property correlations.

#### *Studies on Molecular Structure and Separation Techniques*

Our investigations in the field of molecular structure and separation techniques are mainly aimed at structural and analytical studies of organic compounds by spectroscopic methods and diffraction techniques. Further theoretical and practical development of the methods is also an essential aspect in these activities.

- Crystal and molecular structure investigations by x-ray diffraction
- Chemical structure investigations by optical

and NMR spectroscopy and mass spectrometric methods

- Development and application of optical and NMR spectroscopic as well as mass spectrometric methods for the structure investigation of organic compounds and biomolecules
- ESR spectroscopic investigations
- Study of the correlation between three-dimensional structure, conformation and properties measurable in solution of flexible molecules bound to receptors
- Development of chromatographic methods and procedures related to the study of biologically active compounds.

#### *Research in Quantum Chemistry and Thermodynamics*

Carrying out investigations on the further development of quantum chemical methods and quantum theoretical basic research as well as our earlier elaborated theory on thermodynamics

- Molecular quantum theoretical research
- Thermodynamic research



2. High resolution hybrid-tandem mass spectrometer  
Typ: VG ZAB-2SE0 (VG Analytical, Anglia)

## RESEARCH INSTITUTE OF CHEMICAL ENGINEERING

*Address:* Veszprém, Egyetem u. 2.  
*Postal address:* H-8201 Veszprém, Pf. 125.  
*Telephone:* (36) 80-25-206, (36) 80-25-300  
*Telefax:* (36) 80-24-424  
*Director of Inst.:* János Gyenis C. Sc. (Chemistry)

### Scope of activities

- fundamental research in the field of industrial and engineering chemistry, e.g. exploration of general laws by studying the intrinsic constituents of technological processes in chemical, physical, physico-chemical, and biological conversions
- coordination and evaluation of research in this field of science in Hungary
- scientific cooperation with research institutes and university departments both at home and abroad
- training of experts
- participation in scientific qualification and university education.

A specific feature of research in this field is the fact that whereas exploration of the general laws and their theoretical treatment have to be regarded as fundamental research, the discovered new phenomena and relationships can be used more obviously, more directly in practice, in contracts to other — non- engineering — sciences. This is why the possibilities of practical utilization and the fact that fundamental research and applied research for process and technological development are mutually connected, have always to be considered.



The main building of the Institute

The aim of research at the Institute is to explore the processes going on in bioreactors, and during other chemical or physical unit operations. The main task is to investigate experimentally and theoretically the characteristics of chemical conversion (kinetic properties, mechanisms of processes, intensity, characteristics of intensity), of heat- and mass transfer (heat exchange, heat treatment, drying, absorption, desorption) of alterations in dispersion (crystallization, solution, granulation, agglomeration, disintegration, dispersion, separation of disperse systems, changes in inner and surface structure of solid particles) as a function of material properties and unit operational or process engineering conditions.

It is a specific feature of chemical engineering, of the research of processes and technologies of materials conversion that the investigation of fundamentals and general laws cannot be realized on a miniature scale. Laboratory sized equipment or even larger moduls have to



be constructed, and often connected with each other in order to realize the necessary complex model systems.

### Research aims and topics

*Fundamental research of reactor technical, heat- and mass transfer or other physical processes, as parts of chemical and related technologies*

- development of synthetic processes for the production of pharmaceuticals plant protective materials, and other biologically active compounds; determination of the most important reaction kinetic characteristics and reactor engineering conditions
- research of fluid-mechanical and mixical processes of gas—solid systems, investigation of gas—liquid transfer processes
- investigation of the fundamental relations of difficult precipitation crystallization technologies
- studies on fundamentals of new intensive processes suitable for separating particulate materials from solutions and suspensions with simultaneous morphological changes and thus the development of new, advantageous and useful forms of products
- investigation of processes of dispersion changes in disperse phase systems, in order to describe their general rules by a comprehensive and consistent theory.

*Fundamental research on intensive bioreactors and of downstream processes connected with such biotransformations*

- investigation of mass transfer and hydrodynamic properties of multi - phase bio-reactors, containing biocatalysts immobilized on solid support particles; studies on the biosynthesis of organic molecules

- research of enzyme catalytic reactions in non-aqueous systems, carried out in batch type, or semi-continuous enzyme-reactors
- research of simultaneous heat- and mass transfer processes connected with thermal treatment, chemical, biochemical and physical conversion of complex multi-phase systems
- studies on controlled crystallization and habit modification of bioactive molecules aiming at the production of high purity crystals
- fundamental and applied research of processes for drying, granulation and other types of formations of heat-sensitive, bioactive particulate materials.

*Research in the field of systems engineering, information science and artificial intelligence*

- investigation of the general laws of resonance effects of chemical reactors
- theoretical studies related to discrete optimization of complex technological systems and scheduling of multi-production batch systems
- research on the theoretical foundations of general process synthesis based on a system of axioms
- studies of the possibilities of applying artificial intelligence in chemical engineering
- research on the theoretical fundamentals of quality assurance from the point of view of systems engineering.

*Applied research and projects*

- Based on the results of fundamental research described above the Institute is able to develop effective, economic, and environmentally safe processes and technologies. Such activities have been successfully and repeatedly performed for the chemical,

pharmaceutical, pesticide and food industries for environmental protection, and for the preparation of agricultural raw materials and products.



Batch Operated Sprayed Fluidized Bed Granulator with Mechanical Agitator



## BIOLOGICAL RESEARCH CENTER

Address: Szeged, Temesvári krt. 62.  
 Postal address: H-6701 Szeged, Pf. 521.  
 Telephone: (36) 62-23022  
 Telefax: (36) 62-13726, (36) 62-23600  
 Director of Inst.: Lajos Keszthelyi O.M.

### Scope of activities

#### Basic research.

Initiation and realization of the practical applications of the results obtained in basic research in agriculture, and in the pharmaceutical, food and chemical industries and in medicine. Participation in organized scientific postgradual training, higher education and work of the International Training Course. Publication of the scientific results.

Closest possible cooperation with related institutes of the Academy, universities, and other Hungarian and foreign research institutions. Methodological training of young scientist.

### RESEARCH CONCEPTION OF THE INSTITUTE OF BIOPHYSICS

#### Scope of activities

Basic research using modern physical, chemical and biological methods in the fields of bioenergetics, membrane biophysics, nucleotide chemistry, neurobiology. Research on the self-organization ability of matter and studies of the regulation processes in living matter by physical methods.



Biological Research Center  
 Hungarian Academy of Sciences  
 in Szeged

### Research aims and topics

*Light energy conversion and studies of membrane dynamic phenomena on molecular level*

- Function of light-converting proteins
- Lipid-protein interactions in membranes: studies of the hydrophobic region
- Studies of the structural properties of biliproteins

*Transport of nutrients in cells and targeted delivery of certain drugs into cells*

- Mechanisms of tolerance in plant to environmental stresses
- Redox activity of plasma membranes, iron uptake in cells and effect of cytotoxic substances on these processes

*Complex morphological, biophysical and biochemical characterization of nervous tissue*

- Neural development and thyroid hormones: study of correlations in olfactory bulbs
- Long-term potentiation (LTP): molecular mechanisms
- Neuronal plasticity: role of gamma aminobutyric acid system

#### RESEARCH CONCEPTION OF THE INSTITUTE OF BIOCHEMISTRY

##### Scope of the activities

Basic research using various modern methods applicable in natural sciences, studies of nucleic acids, proteins and lipids and their complexes on different organizational levels. The studies are aimed at better understanding of the chemical and physico-chemical nature of living matter, its changes, regulation of processes taking place in living matter and laws governing life phenomena.

##### Research aims and topics

*Neurobiology projects:*

- Signal transduction mechanism of opioid receptors in brain
- Regulation of GAD gene expression, its function in the developing nervous system
- Function of kappa opioid receptors in the development of the nervous system
- Structure and ligand binding properties of opioid receptors

*Membrane-lipid biology projects*

- Molecular composition of phospholipid membranes and molecular structure and temperature adaptation of phospholipids constituting the membranes

- Studies of temperature stress and adaptation on membrane and molecular levels

*Molecular biology projects  
(gene structure, regulation of gene expression)*

- Characterization of Drosophila ribonucleo-protein nuclease
- Sequence-specific DNA recognition by type II restriction endonucleases and modification methyltransferases
- Studies of transcription trans-activation of retroviruses
- Study of the effect and gene regulation of human TNF alpha
- Regulation of gene coding for connective tissue proteins

#### RESEARCH CONCEPTION OF THE INSTITUTE OF ENZYMOLOGY



The old building of the Institute of Enzymology

##### Scope of activities

Basic research aimed at elucidating the role of enzymes and other proteins in biological processes, regulation of these processes on molecular level, studies of proteins and polypeptides. Improvement of experimental methods and development of their theoretical basis.



## Research aims and topics

### *Structure-function relations in enzymes (proteins)*

- Studies of new protease families
- Structure-function studies of the components of the proteolytic cascade playing a critical role in fibrinolysis and tissue remodelling
- Relationship of protein flexibility, stability and function
- Molecular structure-function studies in multidomain enzymes
- Molecular biology of active transport proteins
- Theoretical and experimental studies of protein primary and three-dimensional structures, stability, dynamic properties and protein design

### *Organization of enzymes and proteins in complex life processes*

- Protein structural basis of neuronal plasticity
- Molecular immunology. Molecular mechanisms of the complement system activation
- Role of dynamic enzyme associations in the regulation of mitosis and glycolysis. Design of selective cytostatic drugs.



Silicon Graphics workstation used for displaying protein structures.

## RESEARCH CONCEPTION OF THE INSTITUTE OF GENETICS

### Scope of activities

Basic research on the mechanisms of heredity and on the processes regulating and influencing the manifestation of hereditary traits on molecular and various other organizational levels

### Research aims and topics

#### *Chromatin structure and gene regulation*

- Genetic and molecular studies of the role of chromatin structure in gene regulation in *Drosophila melanogaster*
- Gene therapy of mammalian cells and animals by means of artificial minichromosomes
- Molecular genetic studies and manipulation of symbiotic nitrogen fixation in rhizobium bacteria and leguminous plants
- Role of heat-shock proteins in regulating gene expression, hormone response and defence mechanisms
- Analysis of those changes occurring in the process of cell differentiation that influence the DNA repair capability of cells on cellular and molecular levels
- Plasmid functions in *B. megaterium*
- Immune regulation

#### *Relations of cell-to-cell communication, signal transduction, cell division and cell differentiation*

- Genetic regulation of cell division
- Role of tumour suppressor genes in regulating cell differentiation and proliferation

## RESEARCH CONCEPTION OF THE INSTITUTE OF PLANT PHYSIOLOGY

### Scope of activities

Basic research in the fields of plant nucleic acids and their metabolism, plant proteins (enzymes), photosynthesis, plant cell genetics, plant viruses and viroids on molecular and various organizational levels.

### Research aims and topics

#### *Relation between structure and function of the photosynthetic apparatus*

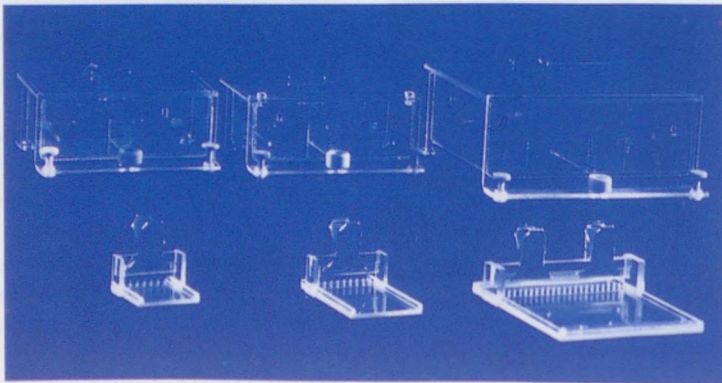
- Studies of the structure of bacterial reaction centres and changes caused in them by herbicide resistance
- Factors regulating energization of thylakoid membranes
- Studies of Photosystem II with special emphasis on the site and mode of action of environmental stresses

#### *Elucidation of the molecular mechanisms of gene regulation*

- Molecular basis and relations of cell division

and differentiation during embryogenesis in cultured plant cells

- Stress response in cyanobacteria (blue-green algae) and studies of production of cyanotoxin appearing on water surfaces
- Studies of genes involved in ontogenesis of *Arabidopsis thaliana*
- Molecular biological studies of the regulation of gene expression in plants, with special emphasis on the small nuclear RNAs and PNPs and investigation of their genes and pseudogenes on structural, functional and evolutionary levels
- Development of methods for gene transfer for application in cytoplasmic improvement of plants
- Light-regulated gene coding for plant GST protein
- Development of the plant regeneration techniques from protoplasts of sunflower
- Production of drought resistant maize by asymmetric somatic hybridization with millet
- Production of maize plants resistant to chlorosulphonic herbicides
- Transfer of yeast artificial chromosomes into plant cells by protoplast fusion



2) DNA Gel Electrophoresis Systems



## BALATON LIMNOLOGICAL RESEARCH INSTITUTE

Address: 8237 Tihany, Fűrdőtelep út 1-3.

Postal address: H-8237 Tihany Pf. 35.

Telephone: (36) 86-48-143

Telefax: (36) 86-48-0006

Director of Inst.: Sándor Herodek C.SC.  
(Biology)

### Scope of activities

Eutrophication studies in Lake Balaton. Feeding and production biological studies of invertebrates and fishes. Physiological studies of aquatic organisms with special reference to regulatory environmental factors. Comparative neurobiological studies.

### Research aims and topics

#### *Hydrobiological research*

The Department of Hydrobiology is involved in basic limnological research. The main topics of research are factors influencing phytoplankton growth in Lake Balaton, competition between algae for the limiting nutrients, and the role of bacteria in the phosphorus cycle. Special attention is given to the littoral zone including faunistic exploration studies of feeding and production of the dominant crustaceans and molluscs, and filtering activity of the periphytes. Early development stages of fishes are intensely studied in the littoral zone.

- Studies of factors influencing production and structure of phyto- and bacterioplankton.
- Taxonomic and ecological studies in the littoral zone of Lake Balaton.



Partial view of the institute

- Studies of reed-attached periphytes, fish communities and trophic interactions in the littoral zone.

#### *Comparative neurobiological studies*

Research in the Department of Experimental Zoology concentrates on the cellular basis of neuronal regulation in invertebrates. In order to understand the functional, neurochemical and chemical-neuroanatomical bases of nervous activity organization, well identifiable regulatory processes are analysed in a complex way.

- Accumulation of environmental pollutants and their effects on the neuronal regulation. The role of different signal systems in

elementary and complex regulation of integration and learning processes.

- Comparative neurobiology of neurotransmitters and transmitter receptors: inter and intracellular connections.



The research vessel "Balaton"



## INSTITUTE OF ECOLOGY AND BOTANY



The former manor-house of Count Vigyázó in the middle of the richest botanic garden of Hungary is the central building of the Institute of Ecology and Botany

*Address:* Vácrátót, Alkotmány u. 2-4.

*Postal address:* H-2163 Vácrátót,  
Alkotmány u. 2-4.

*Telephone:* (36) 27-60-147, (36) 27-60-122

*Telefax:* (36) 27-60-110

*Director of Inst.:* Edit Kovács-Láng C.Sc.  
(Biology)

Studies of structures on different levels of supraindividual organization and processes of community dynamics especially after different disturbances to provide scientific principles for preserving and sustaining the natural and semi-natural terrestrial communities, revealing the tolerable degree of man-made disturbances as well as decreasing and finally stopping further diversity losses and degradation.

### Scope of activities

Theoretical, basic and applied research in certain fields of Ecology and Botany.

Development and care of the collections of the Vácrátót Botanical Gardens. Taking part in postgraduate and professional education.

### Research aims and topics

*Organization and Dynamics of Terrestrial Plant Communities and Populations*

### Main Topics:

- long-term analysis of coenostate-transformations during secondary successions and investigation of the generating mechanisms
- plant-soil tolerance relations
- processes of coenological invasion
- community controlled population dynamics
- developing botanical and ecological databases
- vegetation analysis on landscape scales by the method of Geographical Information Systems(GIS):

### *Hydrobiological Research of Streams and Lakes.*

Investigation of river systems, primarily the hydrobiological basic research of the Danube, with special emphasis on the interactions of biological and hydrobiological processes, impact assessment of anthropogenic effects and natural changes involving biodiversity, water-quality regulation, natural conservation and landscape protection.

Comprehensive limnological investigation of the special water bodies of Lake Fertő, characteristic of that part of the lake on Hungarian territory, in order to establish the strategy for its protection, in Fertő National Park.

Hydrobiological investigation of small water courses of biosphere reserves: physical, chemical and biological measurement of their status, and natural protection evaluation.

- studies of hydrobiological status, bio-diversity, and long-term changes of the different sections of the Danube,
- limnological investigation of Lake Fertő,
- hydrobiological investigation of small water courses of Pilis Biosphere Reserve.

### *Conservation Biology Basic Research for Natural Protection*

Survey of the status of flora and vegetation, terrestrial and aquatic biocenoses, and their populations in Hungary and some tropical coun-

tries; creation of data bases from these data. Assessment of genetic and ecological variability, vitality, competitive and reproductive ability; assessment of conditions for reproduction and artificial propagation of phanerogam and cryptogam plant populations.

Provision of the strategy and techniques for artificial propagation saving and protection of rare endangered species.

- Conservation biology studies of endangered populations of flowering plant species of Hungary,
- Investigations of distribution and characteristic properties of certain cryptogam plant populations of Hungary and some tropical regions.

### *New Plant Resources and their Utilization*

Screening of the biologically active chemical components of indigenous and exotic plant species with the aim of introducing the latter. Search for new crops for food and forage, and of new tree and shrub species suitable for green areas of cities.

- Investigation of production of chemical components of native and introduced species, and their chemotaxonomic evaluation,
- Introduction of new potential crops.

The development and care of the plant collection of the Botanical Garden is a special scientific task for the Institute.



The Valuable dendrological collection in the Botanical Garden of the Institute is especially attractive in autumn



## INSTITUTE OF EXPERIMENTAL MEDICINE

*Address:* H-1083 Budapest, Szigony u. 43.

*Postal address:* H-1450 Budapest Pf. 67.

P.O.Box 67.

*Telephone:* (36) 1-133-1970,

(36) 1-113-7616

*Telefax:* (36) 1-114-1866

*Director of Inst.:* Szilveszter E. Vizi O.M.

### Scope of activities

Research in the fields of experimental morphology, physiology, pathophysiology, biochemistry and pharmacology.

### Research aims and topics

This is the only full-time medical research institute in Hungary. Its research is directed at the most up-to-date problems of the medical sciences. On the basis of traditions as well as its cooperations with various research groups in Hungary, in Europe and in North America the scientific activities of the Institute are focused on the functions of the central and peripheral nervous systems under physiological and pathological conditions. Various aspects of the brain are studied with the help of neuropharmacological, neuroanatomical, neuroendocrinological, neurochemical and neurophysiological techniques.

#### *Neurochemical and neuropharmacological studies*

- The role of adenosine and adenine nucleotides in chemical neurotransmission



The view of the institute

- Heterogeneity of presynaptic receptors. The role of G-proteins in the functioning of presynaptic receptors. Dopaminergic-cholinergic-encephalinergeric (synaptic and non-synaptic) interactions in the striatum.
- The effect of mediators liberated during the immune response on neurotransmission and on hormone release.
- Regulation of neurotransmitter receptor expression.

#### *Neuroendocrine studies*

- Central nervous system regulation of the hypothalamic-adrenocortical system
- The role of hypothalamic structures and

neurotransmitters in the regulation of growth hormone and prolactin secretion

- Studies of mediators inhibiting ACTH secretion
- Proliferative responses and hormone release of normal and adenomatous anterior pituitary cells
- Interactions of mineralocorticoid and glucocorticoid biosynthesis and lipid metabolism in the adrenal cortex; in vitro regulation of the human adrenal cortex
- The role of biogenic amines in the regulation of CRF, ACTH and adrenocortical hormones.

#### *Functional neuroanatomical studies*

Anatomical and neurochemical analysis of the neuronal networks of the archi- and neocortical regions

- Neurochemical modelling of hypoxic brain disease; the role of excitatory neurotrans-

mitters and adenosine receptors in neuronal hypoxic damage.

#### *Cell-biological studies*

- Hormone secretory mechanisms in the human and rat adenohypophysis; the effects of humoral regulatory molecules and various drugs
- Neurochemical maturation of the developing neuronal tissue; the role of cell-biological and molecular factors in the plasticity of the embryonal brain.

#### *Pancreas research*

- Neuronal and humoral factors and their interactions in the regulation of the exocrine pancreas - in vitro and in vivo studies
- the vegetative regulatory effects of the hypothalamic paraventricular nucleus.



Measurement of catecholamines and their metabolites released from the striatum by high pressure liquid chromatography combined with electrochemical detection.



## RESEARCH INSTITUTE FOR VETERINARY MEDICINE

*Address:* Budapest, Hungária krt. 21.  
*Postal address:* H-1581 Budapest, Pf. 18.  
*Telephone:* (36) 1-252-2455  
*Telefax:* (36) 1-252-1069  
*Director of Inst.:* Adorján Bartha D. SC.  
 (Veterinary Medicine)

### Scope of activities

The main aim of the Institute is to investigate the bacterial, viral and parasitic diseases of farm animals and to conduct molecular biology research on these areas. The overwhelming part of the work is basic research. In particular, molecular and genetic aspects are increasingly emphasized. However, the Institute's duties also include participation in different forms of „post-

graduate" training, promotion of international collaborations, informing the public about scientific achievements, and assisting in the technological transfer of research results, for purposes of application.

### Research aims and topics

Most of the research is concentrated on studying genetic material and proteins and glycoproteins of various pathogens. Among the viruses, primarily the Herpes-, Adeno-, Paramyxo-, and tumor-viruses are investigated. Among the bacteria: *E.coli*, *Pasteurella*, *Salmonella*, *Bordetella* as well as *Mycoplasma* are studied for information of their so far less well known virulence characteristics. An important direction of the research is the improvement of methods of detecting infection by nucleic acid



Veterinary Medical Research Institute

and peptide analysis. It is also important to study the relationship between virulence and antigenic composition of the pathogenic organisms. Basic research activities on the protozoa and on fish parasites are related to the etiology of the diseases and to the evolution of protozoa. Environmental health aspects of certain infections are also investigated.

#### *Virology projects*

- Molecular studies on Aujeszky's virus: characterization of the viral genome and its modification to improve immunogenicity.
- Recombinant bivariate Adeno- and Herpes virus vaccines; basic studies and development of models.
- Studies on characteristics of bovine Herpes and Adeno viruses in diseases of farm animals.
- Immunopathology and molecular pathogenesis of reticuloendotheliosis- and chicken anaemia virus infection of birds.

- Immunological and immunodiagnostic studies of avian infectious bronchitis.

#### *Mycoplasma project*

- Immunological studies on the proteins of mycoplasmas in order to explore new ways of diagnosis and protection.

#### *Bacteriology projects*

- Molecular biology of the virulence, epidemiology and immunogenic characteristics of enteric bacteria (E.coli, Salmonella).
- Studies on the Bordetella and Pasteurella infection of domestic animals with special regard to the virulence factors of these strains.

#### *Fish parasitology projects*

- Pathogenesis and therapy of parasitic (myxosporean, coccidian and helminthic) diseases of fishes.
- Studies on viral infection of fishes.



Separation of avian immunoglobulins using LKB Chromatographic System



## AGRICULTURAL RESEARCH INSTITUTE

*Address:* Martonvásár

*Postal address:* Martonvásár Pf. 19.

*Telephone:* (36) 22-79-016, (36) 22-79-215

*Telefax:* (36) 22-79-213

*Director of Inst.:* Zoltán Bedő C.Sc.

(Agriculture)



Main building of the institute.  
Late eighteen century manor-house, built by  
the Brunswick family.

### Scope of activities

The main task laid down in the foundation deeds of the Institute is the execution of research connected with the biology, breeding and production of wheat and maize, the two most important crops of Hungarian agriculture. In addition to a broad spectrum of basic research, great significance is also attached to methodological research, including the improvement of breeding methods and the elaboration of cost-saving, environmentally sound cultivation techniques.

### Research aims and topics

The main aims in the following years will be: research on plant genetics, plant physiology and biotechnology; breeding methodological research; investigations on the inheritance of major agronomic traits; in vitro and in vivo studies on stress tolerance and resistance systems; research on pathological tolerance/resistance; breeding of special quality wheat and maize, research aimed at reducing the use of chemicals; studies on the effect of crop rotation and fertilization on soil fertility.

### *Cell biology research*

The primary aim is the investigation and genetic manipulation of reproductive processes in higher plants. The research team is currently involved with the following projects:

- Development of dihaploid plants with characteristics favourable from an agronomic point of view by means of androgenesis in various cereal species
- Elaboration of the conditions necessary for in vitro gametogenesis and fertilization in wheat, maize, sunflower and *Torenia*
- In vivo and in vitro selection of maize pollen for tolerance to low and high temperatures and to herbicides, also in combination with tissue selection.

### *Genetic research*

The main aim of this research is to carry out genetic analyses on abiotic and biotic stress resistance and to expand the gene reserves for

agronomic traits in cereals. To this end the following projects are planned:

- Development of artificial testing systems and methods; studies on stress-induced biochemical and biophysical changes and on the action mechanisms of plant hormones
- Investigations into the genetic control of stress resistance and examinations on the inheritance of powdery mildew resistance in wheat
- Expansion of the gene pool for agronomic traits in order to reduce genetic vulnerability.

#### *Biochemistry research*

Our biochemistry is aimed at studying interactions between the plant and its environment at various levels of the metabolism for wheat and maize. This involves the following fields:

- Molecular biological analysis of the development of frost resistance
- Molecular genetic studies on the Fr1 gene responsible for frost resistance
- Studies on the effect of cold stress and light inhibition in wheat and maize
- Biochemical analysis of responses to environmental stress factors in maize inflorescences undergoing differentiation
- Studies on the development of tolerance to aluminium ions in wheat and maize
- Investigations into the evolution of direct and indirect sequence replications in chloroplasts.

#### *Wheat breeding and improvement in the genetic background*

- Investigations on in vitro and in vivo stress resistance in order to develop new initial genetic stock

- Development of selection methods designed to improve efficiency and to reduce the time required for breeding
- Improvement in the genetic variability of wheat under suboptimum environmental conditions.
- Elaboration of the genetic and physiological basis for the creation of an extra early wheat maturing at the same time as barley
- Studies on the stability of traits determining wheat quality and on genotype—environment interactions
- Investigations on genotype dependence and on ways of reducing this dependence in another culture
- Examinations on the genetic effect of 1B/1R chromosome translocations
- Inheritance and correlation of grain colour, protein content and quality
- Development of wheat genotypes resistant to biotic stress and adapted to cost-saving, environmentally sound production
- Research on wheat genotypes resistant to abiotic stress factors
- Research into wheat genotypes with various grain qualities
- Research on alternative cereal species

#### *Wheat resistance research*

- Studies on host plant—pathogen relations in the case of wheat powdery mildew: dynamics of changes in races and virulence
- Investigations on the genetic background of resistance to major diseases in wheat
- Research on the methodology of resistance breeding
- Collection, testing and maintenance of resistance sources for use in breeding
- Development of standard inocula from major pathogens for the purpose of provocation experiments



- Studies on the genetic background of the pathological resistance of wheat cultivated in the Carpathian Basin

#### *Wheat agronomy research*

- Determination of the nutrition physiological parameters of wheat varieties with various genotypes and studies on the interactions between these parameters
- Investigations on stress factors and adaptability
- Studies on resistance/tolerance to pathogens: plant physiological aspects of damage and control
- Growth and development analyses, experiments on ripening dynamics
- Agronomic research aimed at improving the efficiency of production technologies
- Elaboration of environmentally sound, cost-saving production technologies based on ecological considerations
- Studies on organic production techniques and agents containing natural materials
- Investigations aimed at improving the efficiency of traditional technological factors
- Long-term trials on irrigation, fertilization, monocultures and nutrient maintenance.

#### *Maize breeding and improvements in the genetic background*

- Expansion of the genetic basis of maize breeding by making use of exotic and adapted genotypes
- Improvements in prediction methods for selecting genotypes capable of increasing the frequency of favourable genes
- Application of reproduction and selection methods to increase the frequency of genes controlling agronomic traits
- Studies on changes in the frequency of genes and genotypes in heterozygotic populations

- Development of maize genotypes with special endosperm compositions
- In vivo and vitro testing of the homogeneity and genetic divergence of maize genotypes
- Studies on the inheritance of tolerance to abiotic stress factors under different ecological conditions
- Investigations on the ecological responses of homozygotic and heterozygotic maize genotypes
- Improvements in selection methods
- Elaboration of a selection system for winter generations raised in the phytotron and „summer“ generations grown in the nursery
- Studies on the effect of artificial and natural ecological systems on maize genotypes with different genetic compositions and vegetation periods
- Investigations on the disease resistance and tolerance of various maize genotypes with respect to major pathogens.

#### *Maize agronomy research*

- Long-term studies on the effect of crop rotation and fertilization systems on soil fertility
- Effect of various ecological and plant production factors on the dynamics of biomass production and growth in maize
- Research designed to promote improvements in maize production: measurements on the direct and indirect effects of plant production factors
- Elaboration of an integrated weed control system for maize
- Characterization and control of interactions between maize production factors and ecological factors
- Elaboration of energy-saving, environmentally sound maize production technologies adjusted to the ecological conditions of production.



Wheat nursery



## RESEARCH INSTITUTE FOR PLANT PROTECTION

Address: Budapest, Heman Ottó u. 15.  
 Postal address: H-1525 Budapest Pf. 102.  
 Telephone: (36) 1-155-8722, (36) 1-156-4691  
 Telefax: (36) 1-156-3698  
 Director of Inst.: Zoltán Király O.M.



The view of the institute

### Scope of activities

This Institute is the research center for plant protection and as such it is involved mainly in basic research in the fields of plant pathology, entomology, pesticide chemistry, herbology and disease resistance of crop plants. In addition to the basic research, most of the individual scientists are involved in postgraduate training, applied research as well as in innovation.

### Research aims and topics

The aim of plant protection research is to reduce crop yield losses by modern management of diseases, insects and weeds harmful in the field. An additional aim is to help environmental protection by creating environmentally safe and sound methods of plant protection. In fact, the final aim of our activities is to understand the biological basis of environment-friendly pest management.

Accordingly, research is carried out in order to understand the biology of plant disease agents, insects and weeds, the physiology of diseased crops, the mechanism of disease and insect resistance as well as resistance of pests to pesticides. Research also covers the genetic manipulation of crop plants to create resistant cultivars,

the composition and alterations of weed biocenoses, reduction of pesticide use in agriculture, the creation of selective pesticides and seeking for alternative methods of management which are environmentally safe and sound.

### Plant Pathology Research

- Host—pathogen relationships in bacterial diseases. Early induced resistance to bacterial pathogens.
- Characterization of viruses of Gramineae and grapevine.
- Wheat stem rust resistance.
- Mechanisms influencing reproduction and variability of *Peronospora* and powdery mildew fungi.
- Molecular taxonomy of *Fusarium* genus, *Fusarium* toxins.
- Mechanism of resistance to late blight of potato.
- Interactions of antagonistic micro-organisms and plant pathogenic fungi.
- Role of free radicals in necrotic disease symptoms and the action of antioxidants in disease resistance.

### *Biochemistry Research*

- Biochemical immunization of cultivated plants.
- Study of biotransformation steps of the formaldehyde cycle with special reference to the stress syndrome.

### *Biotechnology Research*

- Genetic engineering (of potato, tobacco and tomato) for disease resistance.
- Construction of micro-organisms for biological control of plant diseases.
- Use of genetic transformation to introduce *Agrobacterium* resistance into grapevine rootstocks.

### *Insect Pest and Insect Physiology Research*

- Influence of biotic ecological factors on environmentally safe plant protection methods.
- Study of the spread and population dynamics of insects with respect to climatic changes.

- Pheromone biology of agricultural pests previously unapproachable because of methodological problems.
- Hormonal mechanisms controlling development and reproduction of insects.

### *Pesticide Chemistry Research*

- Development of new selective insecticides.
- Natural compounds as potential pesticides.
- Synthesis of low-dose herbicidal ingredients.
- Design and preparation of selective antifungal agents.

### *Weed Biology and Herbological Research*

- Study of multiple resistant weed biotypes in different crops and plantations.
- Naturally occurring phytoherbicides in the Hungarian flora.
- Reduction of herbicide use by micro-herbicidal applications.



## RESEARCH INSTITUTE FOR SOIL SCIENCE AND AGRICULTURAL CHEMISTRY (RISSAC)

*Address:* Budapest, Herman Ottó u. 15.

*Postal address:* H-1525 Budapest, Pf. 35.

*Telephone:* (36) 1-156-4644

*Telefax:* (36) 1-155-8839

*Director of Inst.:* György Várallyay D. Sc.  
(Soil Science)

### Scope of activities

RISSAC is the scientific centre in Hungary for soil science, agrochemistry and soil biology. The Institute is responsible primarily for fundamental research in these fields with significant applied research, education, advisory and information activities, and extensive national and international cooperation.

### Research aims and topics

#### *Soil Science*

Development of an up-to-date GIS-based Soil Information System with the application of

modern mapping techniques and remote sensing.

Quantitative characterization of spatial and time variabilities of soil properties; and the development of a monitoring system for the continuous registration of soil processes and soil changes under various conditions.

Description and quantification of the mass and energy regime of soils, their factors and mechanisms for their prediction and control.

Identification of various soil functions (media for biomass production, filter and buffer function, etc.) and their multidisciplinary evaluation.

#### Main research projects:

- development and testing of optimum methods for soil and land-site mapping;
- territorial (spatial) estimation of hydrophysical properties and moisture regime of soils, their quantitative mapping and monitoring, and the evaluation of their agroecological impacts;
- description, quantification and modelling of soil degradation processes (with particular attention to acidification, salinization-alkali-



View of the main building of the Institute

zation and structure destruction) for their prediction and prevention;

- study of the transport and transformation processes of heavy metals in the soil—water—plant system;
- evaluation of the role of biotic and abiotic factors in the micro-scale soil processes and plant nutrient regimes in the soil—plant roots micro-environment;
- „in vivo” and „in loco” gas analytical investigation with the application of quadrupole mass spectrometry.

### *Agrochemistry*

Determination and quantification of the spatial and time variabilities of the various forms of plant nutrients in soils; status and dynamics of plant nutrients in the soil—plant roots micro-environment; the up-to-date evaluation and characterization of the „plant nutrient supply” function of soils and possibilities of its regulation.

Determination of the nutrient uptake and fertilizer response of the main cultivated crops and - on this basis - the development of a modern plant nutrition system and advisory service based on soil tests, plant analyses and long-term field experiments.

Studies on the possibilities of plant nutrient transport from soil to surface- and subsurface water resources (their mechanisms, determining and influencing factors) for the prevention of point and non-point water pollution from agricultural sources.

Development of a plant stress detecting system for the quick, correct, accurate and territorial registration of natural and/or human-induced plant stresses during the vegetation period, giving potential possibilities for their rapid elimination or moderation.

Contribution to the development of soil/ agrochemical/soil biological basis of sustainable agriculture under the changing structure of agricultural production.

### Main research projects:

- study of nitrogen transport and transformation in the soil—water—plant system;
- evaluation of phosphorous mobility and availability under different weather and soil conditions and land use practices;
- the impact of long-term fertilizer application on soil functions, primarily to soil fertility;
- limiting factors of soil fertility in sandy soils;
- application of plant analysis for the diagnosis of various crops;
- identification of the relationships between the nutrient supply of plants and the quantity and quality of the yield, disease and insect tolerance of crops, and the efficiency of pesticide application;
- analysis of heavy metal contamination in the environment;
- adaptation, testing and development of simulation models describing and characterizing the soil—plant—atmosphere relationships in various agro-ecosystems;
- the environmental impacts of over-fertilization; the influence of ion-stresses on plants and soils.

### *Soil Biology and Biochemistry*

Studies characterizing the „biological activity” of soils; and for determining and quantifying the existing relationships between soil microorganisms, soils and plants in various natural, semi-natural and agro-ecosystems.

Study of the distribution and population-dynamics of endomycorrhizae in natural, semi-natural and agro-ecosystems and charac-



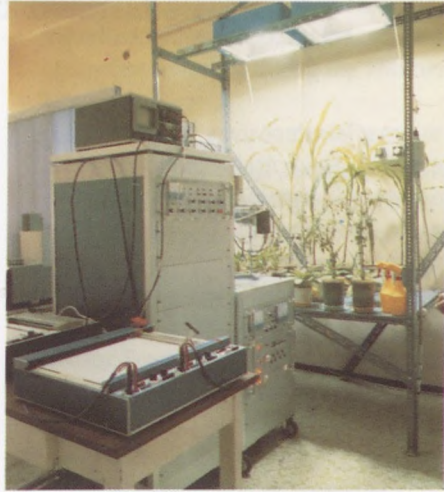
terization of their role in the moisture, mass and nutrient regimes of the soil—water—plant system.

Quantitative and qualitative characterization of monocotyledon-associated N<sub>2</sub>-fixing Azospirillum species under various ecological conditions.

Evaluation of the role of various soil enzymes (primarily amidase and phosphatase) in the nutrient regime of various ecosystems.

#### Main research projects:

- studies for characterizing the „biological activity“ of soils;
- evaluation of the potential possibilities for the biological improvement of the efficiency of available nitrogen in soils;
- determination and quantification of the existing relationships between soil microorganisms, soils and plants in various natural, semi-natural and agro-ecosystems.



New inlet system for quadrupole mass spectrometry measuring stress responses, of plants, caused by different chemical treatments

## GEOGRAPHICAL RESEARCH INSTITUTE

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*Postal address:* H-1388 Budapest Pf. 64.  
*Telephone:* (36) 1-111-6832, (36) 1-131-7325  
*Telefax:* (36) 1-131-7991  
*Director of Inst.:* István Berényi D. Sc.  
 (Geography)

### Scope of activities

Theoretical basis, methodology and development of physical, socio-economic and regional geography; survey of spatial processes and interrelationships; temporal and spatial investigations into the interactions between man and environment, assessment of factors of the geographical environment with special reference to the research of natural and socio-economic resources, to the socio-geographical problems of Hungary, of the Central European macro-region and of distinct territorial units within them (meso- and microregions, districts, administrative units); international cooperation; publication and documentation of results (in Hungarian and foreign-language studies, journals and other publications)

### Research aims and topics

Enlargement of the environmental scope of relief assessment, geomorphological and geocological mapping (surface movements, soil erosion and other man-induced processes; ecological impact of flood control; identification of surfaces with increased concentration of radio-isotopes; exploration of sites suitable for waste



Main building of the Institute

disposal; economic geographical evaluation of primary natural resources and mineral reserves). The chronological subdivision of Quaternary formations, loesses, other loose sediments and paleosols as well as crop specific relief suitability assessment create a basis for a more complex environmental evaluation, agro-ecological zoning, delimitation of types of agricultural habitat, and effective utilization of environmental potentials.

Analysis of global and regional consequences of the recent European socio-economic transformation in international cooperation. The new stage of social evolution in Europe is characterized by an expansion of regionalism and there is a trend toward intensification of interrelationships between cultural macro-landscapes and within mesoregions. Consequently, disciplines such as political and ethnic geography, and geography of religions — neglected for sev-



eral decades, still playing a significant role in shaping regional identity — should be raised to international level, both theoretically and methodologically. Complex social geographical research of Hungarian regions (e.g. Danube Bend) should be further developed to survey major fields of conflicts between man and environment, society and nature.

Modern analysis of spatial relationships and conflicts between „nature-economy-society“ can be performed using Geographical Information Systems (GIS). This enables further clarification of modifications of the geosystems of primary importance; of the spatial and temporal pattern concerning their structural changes, evaluation of the state of the environment of the country and of her regions, and the monitoring of trends. Along with providing topics for fundamental research, the results of investigations can serve for decision-making on environmental policy issues and regional planning. Updating the National Atlas of Hungary would also present a realistic situation of the country within a wider context, as a part of the European and macro-regional socio-economic processes.

*Relief assessment, geomorphological and geoecological mapping, investigation of younger geological formations and geomorphic processes*

- Geographical assessment of production and industrial sites, their engineering-geomorphological mapping
- Paleogeographical mapping of the Northern Hemisphere
- Further methodological development of geoecological mapping in Hungarian type regions (Transdanubian Mountains)
- Studies on the relief evolution of Hungary and on younger geological formations

- Investigation of geographical and ecological impact of activities on flood control and drainage system formation during the 19th century
- Elaboration of environmental geomorphological, paleoecological and settlement environmental criteria of capital investments and computer-aided waste disposal site selection
- Utilization of geomorphological methods to identify sites in the surroundings of the Paks Nuclear Power Plant where there may be increased radioisotope content.

*Territorial (value) cadaster of natural resources: Instrumental measurement and computer modelling of soil loss, agroecological zoning (evaluation)*

- Assessment of soil and nutrient loss caused by erosion processes in the Lake Balaton catchment area. A contribution to the conservation of the lake ecosystem (a joint project of the Hungarian Academy of Sciences with the Deutsche Forschungsgemeinschaft)
- Assessment of soil loss in agricultural areas of East Styria, Austria
- Soil erosion research using methods of remote sensing
- Agroecological microzoning based on crop specific land suitability in Pest and Bács-Kiskun counties.

*Social geographical research of processes of socio-economic transformation and its spatial impacts*

- Survey of trends of the changes in the settlement network and of those within the individual settlements
- Political geographical studies
- Ethnic geographical studies

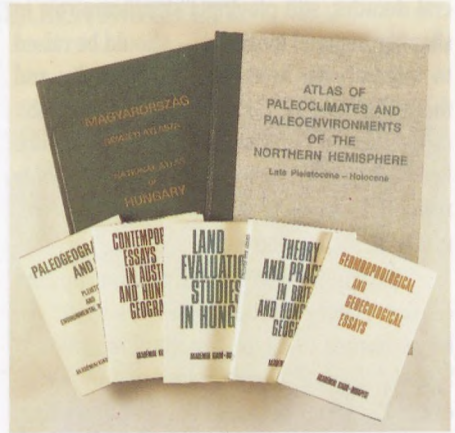
- Social geographical research relating to the Danube Bend
- Investigations into the fields of social tensions from the geographical standpoint.

*Investigations into and evaluation of the dynamics and changes in potentials of environmental systems*

- Research of the temporal organization of geosystems, of the interrelationships between landscape factors and of their intensity
- Theoretical and methodological questions (thresholds) of man-induced loadability of geosystems (landscapes)
- General evaluation of the state of the environment in Hungary

*Landscape geographical description of Hungary*

- Compilation and design of new sheets for the National Atlas of Hungary



Different publications of the institute

The Institute elaborates different topics to the extent of its financial sources and seeks for further support through contracts and tenders. From the financing viewpoint the Institute is essentially a non-profit organization.



## GEODETIC AND GEOPHYSICAL RESEARCH INSTITUTE

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*Director of Inst.:* Péter Varga D. Sc. (Geology)



Main building of the Geodetic and  
Geophysical Research Institute in Sopron

### Scope of activities

Basic research in geodesy and geophysics including theory, field- and laboratory work and processing needed for the topics, publication of scientific results and of measured data; running and development of geophysical observatories for seismology, geomagnetism, ionosphere and geodynamics, and regular publication of the data observed. Development of scientific methods and instruments; providing assistance and support for various institutions in solving their geodetic and geophysical problems of basic research character; participating in the work of international geodetic and geophysical organizations and carrying out the task arriving at the Institute in consequence of the membership of Hungary in international organizations.

### Research aims and topics

In the field of geophysics the application of seismology and electromagnetic induction in the study of the Earth's structure, further the study of certain fields of solar - terrestrial physics, such as higher atmosphere, lower ionosphere, magnetospheric physics, geomagnetic variation field.

In the field of geodesy our aim is to continue the research work in mathematical geodesy and to develop the measuring methods and instruments as well as to carry out studies in geodynamics (earth tides and gravimetry, recent crustal movements, rotation of the earth, etc.).

The observatory network has to be integrated more and more into the international network. It is planned to install modern instruments in the seismological observatory at Piskéstető with German support; after that the station can be integrated into the German uniform seismological network. This will enable a more precise and rapid localization of earthquake epicentres as well as the study of earthquake physics at higher level. Similarly the installation of an INTERMAGNET compatible automatic geomagnetic station at the Nagycenk geomagnetic observatory makes possible the connection to the global INTERMAGNET network via satellite data transfer.

The complex application of geodetic and geophysical investigation methods opens up new and up-to-date research themes for the

Institute by means of the cooperation between physical geodesy and seismology, geodynamic stations can be used as long-period seismological observatories; moreover pre- and postseismic phenomena can be investigated by the geodetic study of movements. A new field of research with international links is the study of the connection between the processes varying in time of the space around the Earth and of the Earth itself, the science of the environment increasingly to utilize geophysical and geodetic methods. In this respect, an important task of the Institute is to develop the theoretical and experimental methodology.

### Main topics

#### *Aeronomy:*

- Study of the interaction between corpuscular radiation and the upper atmosphere
- Study of the dynamics of the lower thermosphere
- Solar - terrestrial relations in the upper atmosphere

#### *Geodetic measuring methods:*

- Increase of accuracy and automation of geodetic measurements by up-to-date electronics and image-sensing methods
- Observing instruments of time-varying geodynamic processes.

#### *Geodynamics:*

- Study of the evaluation methods of measurements by gravimeter, extensometer and horizontal pendulum and interpretation of the

- results from the geodynamic point of view
- Observation of the gravity field and the study of its structure from the geodynamic point of view
- Application of the Global Positioning System (GPS) to geodynamic and geophysical purposes
- Study of the rotation of the Earth around its axis

#### *Electromagnetic induction:*

- Study of the electrical structure of the Earth's crust and upper mantle in the Pannonian basin and in the surroundings (Alps, Carpathians, East European Platform) and their relationship with the physical state of the Earth's interior
- Solving of three-dimensional interpretation problems of electromagnetic induction measuring results by analogue- and mathematical modelling
- Theoretical study of the causes of different electromagnetic distorting effects (electric charges, current distribution)

#### *Magnetosphere - geomagnetic pulsations*

- Improvement of geomagnetic recordings at Nagyecenk observatory,
- Study of the magnetosphere by geomagnetic pulsations

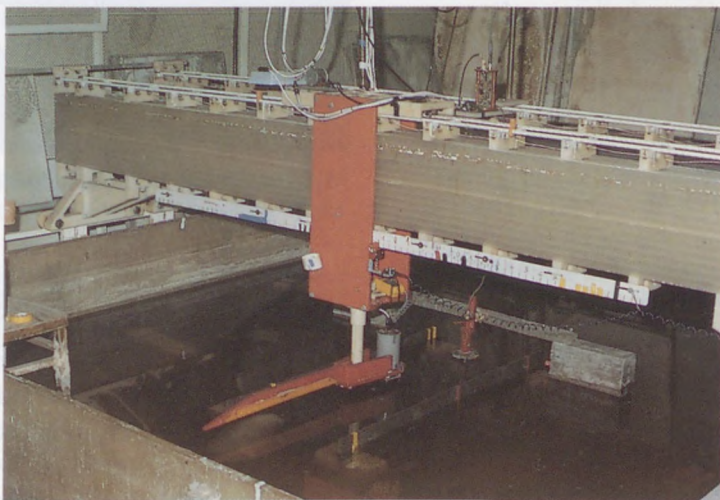
#### *Mathematical geodesy:*

- Application of mathematical methods in the geosciences
- Modern systems in geodesy
- Geoinformatics



*Seismology:*

- Investigation of structure and earthquake sources of the Carpathian Basin by seismological data
- Study of the seismically active areas in Hungary and the estimation of the seismic risk
- Methodological problems of seismology
- Development of the seismological observatory network and running the tasks of the seismological service
- Seismic control of the prohibition of underground nuclear experimental explosions



Analogue modelling equipment for three-dimensional interpretation of electromagnetic measurement and for analysis of EM Earth structures.

## RESEARCH LABORATORY FOR MINING CHEMISTRY

*Address:* Miskolc-Egyetemváros

*Postal address:* H-3515 Miskolc,

Egyetemváros Pf. 2.

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*Director of Inst.:* József Tóth D. Sc. (Chemistry)



Research laboratory for mining chemistry

### Scope of activities

Mining chemistry is a special branch of the sciences. Basically it deals with the chemical problems of exploration and recovery of solid, liquid, and gaseous systems existing in underground reservoirs. The fundamental and applied research in this scientific field covers the whole spectrum of phenomena that influence technical efficiency. Thus, mining chemistry aims not only at a better understanding of different mechanisms but also at a contribution to the development of advanced technologies.

The Laboratory consists three Scientific Departments dealing with research in chemistry, reservoir engineering and development of special instruments.

### Research aims and topics

*Fundamental and applied research in the Chemical Engineering Department cover the analytical, physico-chemical and colloid chemical aspects of the following problems:*

- Determination of the composition of reservoir fluids (oil, natural gas and formation

water) by up-to-date analytical techniques (IR, UV-VIS, GC, VPO, AAS, OES).

- Equilibrium conditions in oil (water) rock systems at different pressures and temperatures up to 200 bars and 150°C and determination of interfacial tensions, as well as the study of ionic processes (dissolution, ion exchange, inorganic chemical reactions, etc.) in the presence of EOR chemicals and dissolved gases (hydrocarbon gases, CO<sub>2</sub> and N<sub>2</sub>).
- Complex rheological studies on homogeneous and disperse systems (crude oils, suspensions, emulsions, molecular colloids) under low shear rates (10<sup>-3</sup> - 10 s<sup>-1</sup>).
- Profile modification in oil and/or gas producing and injection wells, the corresponding fundamental and applied research in controlling horizontal water and gas coning by in-situ generated combined polymer/ silicate gels.

*The Reservoir Engineering Department deals with fundamental and applied research concerning petrophysical studies under reservoir conditions*



and improved oil recovery as follows:

- The effect of overburden and pore pressure on porous or dual porosity systems.
- Determination of diffusion and dispersion coefficients in porous materials under different water saturation conditions in gas (gas, gas) (liquid and liquid) liquid systems up to 400 bars and 150 °C.
- Linear and radial displacement tests in 0.20-1.20 m long, 3 cm diameter and in full core diameter sandpacks, natural or synthetic cores made of actual core materials, up to 300 bars and 200 °C for selecting optimal composition and slug size of the displacing agents.

*The activities of the Department for Research Instrumentation are concentrated on the development of new laboratory instruments*

*corresponding to standard and special requirements. The current equipments developed and manufactured by the Department for Research Instrumentation are as follows:*

- Single or double cylinder (tandem or twin) high pressure volumetric pumps in horizontal or vertical arrangements for liquid (e.g. mercury) or gas displacement up to 1000 bars with constant or variable rates.
- Blind PVT cells.
- High pressure rolling ball viscosimeter for liquids operating up to 500 bars and 150 °C.
- Capillary pressure apparatus operating up to 200 bars and 120 °C.
- High pressure IFT meter for the determination of interfacial tension (IFT) in transparent liquid or liquid / gas systems by the pendant drop method up to 300 bars and 200 °C.



Automatic programmable PVT system for volumetric and phase study of crude oil reservoir samples under reservoir conditions.





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