Questionnaire

Summary of the main activities of a scientific Organisation of the Slovak Academy of Sciences

Period: January 1, 2003 - December 31, 2006

I. Formal information on the assessed Organisation:

1. **Legal name and address**

   Ústav merania

   Institute of Measurement Science

   Dúbravská cesta 9, 841 04 Bratislava

2. **Executive body of the Organisation and its composition**

Directoriat	name	age	years in the position
director	Assoc.Prof. Milan Tyšler, PhD.	55	2006 -
deputy director	Assoc.Prof. Viktor Witkovský, PhD.	43	2006 -
scientific secretary	Ján Maňka, PhD.	45	2006 -

3. **Head of the Scientific Board**

   Assoc.Prof. Viktor Witkovský, PhD.

4. Basic information about the research personnel

i. Number of employees with a university degree (PhD students excluded) engaged in research and development and their full time equivalent work capacity (FTE) in 2003, 2004, 2005, 2006 and average number during the assessment period

ii. Organisation units/departments and their FTE employees with the university degree engaged in research and development

Research staff	2003		2004		2005		2006		average	
	No.	FTE	No.	FTE	No.	FTE	No.	FTE	No.	FTE
organisation in whole	39	32	44	35,2	41	33,9	47	35,6	42,75	34,175
Department of Optoelectronic Measuring Methods	11	9,25	12	9,7	9	7,56	10	8,34	11	8,71
Department of Magnetometry	12	9,95	12	10,2	13	10,94	10	8,62	12	9,93
Department of Theoretical Methods	7	4,4	8	4,8	8	5,2	14	7,94	9	5,59
Department of Imaging Methods	4	3,7	6	4,8	6	5,4	8	5,9	6	4,95
Department of Biomeasurements	5	4,7	6	5,7	5	4,8	5	4,8	5	5

5. Basic information on the funding

i. Total salary budget[1] of the Organisation allocated from the institutional resources of the Slovak Academy of Sciences (SAS) in 2003, 2004, 2005, 2006, and average amount for the assessment period

Salary budget	2003	2004	2005	2006	average
total salary budget (millions of SKK)	14.963	15.203	15.616	15.679	15.365

6. URL of the Organisation's web site

Slovak version: http://www.um.sav.sk/sk/

English version: http://www.um.sav.sk/en/

[1] Sum of the brutto salaries without the fund contributions.

II. General information on the research and development activity of the Organisation:

1. Mission Statement of the Organisation as presented in its Foundation Charter

1. The Institute is specialised to basic research in measurement science and mathematical methods for processing and computer imaging of measured data. It is concentrated to development of non-traditional methods for measurement of selected physical quantities and some parameters important in biomedicine, using laws of physics, mathematics and biophysics.
2. The Institute is oriented to design of methods and measuring systems dedicated to non-standard measurement problems in the research and industry. It develops and implements unique measuring systems as materialised result of the scientific research carried out in the Institute.
3. The Institute offers advisory and other expert services related to the main activities of the organisation.
4. The Institute performs postgraduate scientific education governed by valid legislative regulations.
5. The Institute publishes results of the scientific research in periodic and non-periodic press. Publishing of own periodic and non-periodic titles obeys the decisions of the Presidium of the Slovak Academy of Sciences.

2. Summary of R&D activity pursued by the Organisation during the assessed period, from both national and international aspects and its incorporation in the European Research Area (max. 10 pages)

In concordance with its Foundation Charter, activities of the Institute of Measurement Science SAS encompass following basic domains of fundamental and applied research:

- Measurement theory, mathematical and statistical methods for processing of measured data;
- Principles and systems for measurement of selected physical quantities;
- Measuring systems for biomedicine, mathematical and computer modelling of biological structures and processes, processing of biosignals;
- Design of methods and measuring systems for non-standard problems of measurement in science and industry, technologies for non-destructive or non-invasive diagnostics.

Research activities of the Institute are organized within 5 scientific departments: Department of Optoelectronic Measuring Methods, Department of Magnetometry, Department of Theoretical Methods, Department of Imaging Methods and Department of Biomeasurements. In following paragraphs, main research activities of the departments during the assessment period will be introduced and their role and positions in national and international scientific cooperation will be outlined.

Research activities of the Department of Optoelectronic Measuring Methods were focused into these major domains:

- optical frequency stabilisation of diode lasers by saturated absorption method,
- infrared thermometry and thermography,
- use of optoelectronic methods in non-destructive testing,

- electronic measuring systems for experimental relativistic physics,
- optoelectronic methods of vertical axis drift measurement of large-scale objects.

Research of optical frequency stabilisation of diode lasers by saturated absorption method was financially supported by the grant agency APVT under project APVT-51-0121-02 entitled “Research of optical frequencies stabilization of diode lasers”

The fundamental goal of the project was the research of features of semiconductor lasers with high frequency stability which have been intended for use in length metrology. Solved project was connected with the development of a new National length standard based on semiconductor lasers in accordance with world-wide trends. In the frame of the project, the 633 nm diode laser system with extended resonant cavity was realised. Its optical frequency spectrum (~ 474 THz) can be stabilised by frequencies of hyperfine components of the iodine molecule quantum transitions. As for the originality of the project, it has to be highlighted that lasers used in the project have relative uncertainty in the range 10^{-11} - 10^{-12}, whereas commercially available lasers have relative uncertainty in the range 10^{-7} - 10^{-8}.

Research in infrared thermometry and thermography was supported by the Scientific Grant Agency under project VEGA 2/3180/23 entitled “Infrared thermometry, thermography and reflectography – development of selected methods and tools”. Theoretical research was aimed at analysis of selected problems of infrared radiometry, thermometry and thermography. Optical properties of materials in infrared region and emissivity as significant source of uncertainty of contactless temperature measurement were analysed. Having in view potential application in industry, special emphasis was given to different types of aluminium surfaces and its alloys.

Thermal sensitivity of a single infrared detector, mechanically scanned single detector and matrix infrared detectors were theoretically analysed. A comparative study of commercial thermography systems was developed. This study was the aid for four institutes of the Slovak Academy of Sciences when selecting the most appropriate thermographic systems for different research and application fields. In the experimental part of the project, a high temperature thermography system based on a silicon CCD detector and a single chip microcontroller was developed. System was used in the research of spatial thermal inhomogenities of black-body sources. Another important result of the project was development of fast infrared thermometers for contactless temperature measurement that were used in several technological applications, e.g. IRT 48 in aluminium foam production (Institute of Materials & Machine Mechanics SAS).

Research of optical methods in non-destructive testing was conducted within the framework of EU COST G8 project “Non-destructive analysis and testing of museum objects”. The research was aimed at the development of optical testing methods and systems for non-destructive testing of various objects - mainly historic paintings and other works of art. Main emphasis was given to the development of two optical non-destructive methods – near infrared reflectography and ultraviolet fluorescence with digital image postprocessing. These methods are useful for visualisation of hidden underdrawings, signatures or datings in pictures, testing of paintings which have been repainted or degraded in the course of time. Non-destructive methods developed in the frame of the project have been applied in cooperation with the Chamber of Restorers, the Academy of Fine Arts and Design and National Institute for Monuments Protection, Slovakia, by testing the artefacts of our cultural heritage.

Research of electronic measuring systems for experimental relativistic physics was conducted within the framework of international cooperation with Joint Institute for Nuclear Research in Dubna (Russia). The main emphasis was put on the development of diagnostic methods and systems for extracted particle beams from Nuclotron accelerator. In the frame of this project, the method of geometric parameters of extracted particle beams was developed and consecutively the apparatus able to measure these

parameters, particularly in region of low intensity conditions of beams, was constructed. Under these beams conditions no other known methods are usable. The system is used in the JINR.

Next important topic of the research was development of methods and systems for magnetic field cycle control of the Nuclotron accelerator. This was solved in the framework of the new Nuclotron control system project that substantially extends the functionality of the accelerator. System will be finished next year.

Within activities in optoelectronic methods for vertical axis drift measurement of large-scale objects systems for nuclear reactor tilt monitoring have been developed and installed in nuclear power stations in Slovakia. During the assessed period, the activities were concentrated to regular data measurement, processing, presentation and analysis, to calibration of all installed systems and to special service of installed systems.

During the processing of measured data at the end of 2004, parallel motions of all monitored reactors were detected. As consecutively learned, the reason of these motions was the earthquake in south–west Asia. After this, all more significant earthquakes in the world were reliably detected. These measuring systems obtained the “Slovak Gold award” in 2004.

In the Department of Magnetometry the research was focused to four main areas:

- basic research of magnetopneumographic methods and systems,
- research of superconducting quantum magnetometric (SQM) systems,
- development of special devices and technologies for magnetometric measurements,
- research of materials and technologies for high temperature superconductivity (HTS).

In the field of magnetopneumography a methodology and equipment for a magnetometric method of quantification of ferromagnetic contamination in a live organism’s respiratory system by a non-invasive method has been developed. The Institute currently has a laboratory SQUID magnetometric system of its own construction allowing to identify and quantify low concentrations of ferromagnetic particles in living tissues. Mathematical model of lung segments configuration was created and magnetometric method for determination of the average concentration of the ferromagnetic contamination (FC) deposited in the tissues of human respiratory system was developed. The equipment enables non-invasive contactless measurement of dusting of lungs and respiratory system, while its sensitivity, i.e. the minimal measurable concentration of FC, ranges depending on its magnetic properties, magnetization intensity and required signal/noise ratio from 20 to 600 μg/cm^3. The measured course of remanent magnetization of pre-magnetized FC in lungs is corrected by a programme, while anatomic parameters of a specific chest and relaxation processes are considered. Information about average lowest measurable area densities of individual powder ferromagnetic materials, their specific magnetic moments, and a set of relaxation characteristics have been obtained. An original conception of electronic calibration and measurement of magnetic susceptibility of human body organs in altering magnetic field (at the frequencies of 2.8 Hz and 11 Hz) in vivo and measurements of selected types of samples of biological materials defined in terms of shape (cylinder, square) and volume [(1÷100) cm^3] in vitro has been prepared. A large-sized (~ 2,5x3 m^2) Helmholtz magnetization system with the magnetizing field amplitude of 2.10^{-4} Tpp has been solved (5-time increase when compared to the previous state) with increased mechanic stability (reduction of microvibrations).

Such magnetopnuemographic equipment is unique in Slovakia and surrounding countries and has technical properties comparable to equipments of a similar type available at the above-stated foreign workplaces. However, when compared to them, our system has lower sensitivity by about one order, which is caused mainly by the fact that we do not use expensive magnetic shielding. The system is suitable mainly for a periodical monitoring of persons, who work in risky working environment (electric arc welders,

certain metal-working professions, workers of metalworks, or dental technicians). In clinical practice, especially in industrial medicine, magnetopneumography provides immediate information with diagnostics of specific occupational diseases, such as pulmonary fibrosis or welder's pneumoconiosis.

According to our information, no complete magnetopneumatographic system is available yet. Our magnetopneumatographic measurements have been performed in cooperation with Clinic of Labour Medicine and Toxicology, Medical School, Commenius University, and Department of Gastroenterology, Slovak Healthcare University.

Results obtained in the area of magentopneumography rank our Institute to such laboratories as National Research Centre for Environment and Health, Institute for Inhalation Biology, Munich, Germany, Forchungszentrum fur Umwelt und Gesundheit. Institut fur Biophysikalische Strahlenforschung, Frankfurt am Main, Germany, Department of Environmental Science and Physiology, Harvard School of Public Health, Boston, MA, USA, Department of Physics and Astronomy, Vanderbilt University, Nashville, USA, University of Oulu, Oulu, Finland, Tokyo Denki University, Hatoyama, Saitama, Japan.

In the research of superconducting quantum magnetometric (SQM) systems we have contributed to the development of new measuring methods by detailed theoretical analysis of properties of receiving system of the HF magnetic field with SQM for NMR tomography systems with a low magnetic field (Low-Field-NMR). Equations for their input equivalent spectral sensitivity of the magnetic flux density have been deducted, including effects of the noise of the active and passive elements in the measuring chain. From the analysis it results that the limit input equivalent spectral sensitivity ranges from 10^{-19} to 10^{-17} $THz^{-1/2}$. Advantages of a system with SQM can be fully applied mainly at NMR spectroscopy of small-sized samples of the solid phase.

Developing devices and technologies for magnetometric measurements. We have improved the SQUID gradiometric system designed for measuring magnetization characteristics of HTS based on the compensation measuring method. Based on the analysis of temperature processes, measuring procedures have been optimized, and a decrease in the effect of the temperature instability of the magnetizing system on the accuracy of the measured values at lf-level of the magnetization field (~ 200 mT_{pp}) has been reached. In combination with a computer correction of the temperature dependence of the compensation, a reduction of the measurement inaccuracy to the half level of the original value has been reached.

The Institute of Measurement Science has built a laboratory for measurement of magnetic fields (including RF and DC SQUIDs magnetometers, superconducting gradiometric antenna and cryogenic LN_2 and LHe equipments). In the area of the material research in this evaluated period, we have successfully completed the building of the basic infrastructure of a chemical laboratory specialized in HTS synthesis including tree tube resistance furnaces as well as a supercanthal furnace for the preparation of precursors by the QMTG method; and a laboratory of automated transport and inductive measurements of R-T and U-T dependencies and a laboratory of optical polarized microscopy and XRD data analyses are under construction.

In research of materials and technologies for HTS a technological procedure for preparation of volume polycrystalline and high textured samples of HTS of the $REBa_2Cu_3O_{7-\delta}$ type for RE= Y, Eu and Sm has been optimized. For example, we are able to prepare polycrystalline samples with reproduced parameters, such as the volume density of $\rho > 0.9\ \rho_{th}$, the critical temperature ≥ 92 K, maximum volume magnetization, M (for samples with the weight ~ 1.25 g) ≥ 14 000 Am^{-1} and the first penetration magnetic field of H_{p1} ~ 1500 Am^{-1}. Technological parameters allowing regulation of values of the specified characteristics have been found. Synthesis conditions have been optimized and substituted systems of $RE_{1-x}L_xBa_2Cu_{3-y}M_yO_{7\pm\delta}$, where RE = Y, Sm, L= Sc, Ti a M = Sc, Ti, Ge, Ag, Ru and dopped systems of $REBa_2Cu_3O_{7-\delta}$/Mo, where RE = Eu, Sm and Mo =

Ag_2O, Ge_2O_3, SnO_2, TiO_2, Ni, NiO, Ga_2O_3, Y211 have been prepared. A different effect of several additives, when compared to the Y123 system has been ascertained, e.g., for Ag, Sn and Ge. In the $YBa_2Cu_{3-x}Ti_xO_{7-\delta}$ system, where x=0 - 1,2 up to the highest levels of Ti, a superconducting phase has been present. Contrary to the currently reported results, we have observed the formation of sold liquids of $YBa_2Cu_{3-x}Ti_x0_y$ up to x = 0.3 for optimized synthesis parameters. For x≤1.0, Tc changes slightly only, contrary to volume superconducting properties and microstructure.

A technology has been developed and samples of synthetic bismuth dopped yttrium-iron garnet (Bi: YIG) and targets for a preparation of a planar TF indicator for displaying magnetic fields of HTS by the magneto-optical method have been prepared.

A multipurpose measuring system, KO_PCH_R-I-06, for the measurement of transition characteristics of HTS by a transport and mutual induction methods has been extended by new functions (measurement of higher harmonics of induced voltage signals vs. temperature, with the use of the Brüel&Kjaer analyser). The system also allows measuring of the temperature dependences of thermoelectromotoric voltages of HTS and calibration of various temperature sensors within the range of (60-300) K or (4.2-300) K. The measuring process is controlled by a PC and hardware and software systems.

Scientific research in the Department of Theoretical Methods has been aimed at development of theoretical methods in the area of mathematical statistics and applied mathematics. Basic and applied research of the Department was focused mainly on research

- in the theory of probability and mathematical statistics,
- of artificial neural nets,
- of non-linear dynamics,

with orientation towards problems of measurement and evaluation of measured data in different interdisciplinary research areas.

During the assessed period the Department has had scientific cooperation with research partners both in Slovakia and abroad (e.g. Faculty of Mathematics, Physics and Informatics, Comenius University, Bratislava, SK, Mathematical Institute of the SAS, Bratislava, Institute of Computer Science Academy of Sciences of the Czech Republic, Prague, Faculty of Natural Sciences, Palacki University, Olomouc, CZ, ARC Seibersdorf Research GmbH, Austria, Medical University Innsbruck, Austria, Austrian Research Institute for Artificial Intelligence, Vienna, Austria, LSU Health Sciences Center, School of Public Health, New Orleans, USA). In 2006 the Institute co-organized the Fifth International Conference on Probability and Statistics PROBASTAT 2006, held in Smolenice Castle, Slovak Republic, on June 5 - 9, 2006.

In basic research, new results have been derived for estimation of parameters and statistical inference in linear and nonlinear models: We have investigated invariant quadratic estimators of variances in the orthogonal linear regression model with finite discrete spectrum and compared with estimators based on maximizing the likelihood (ML and REML). We have suggested a new method for a linearization of the nonlinear regression. In the area of the linear regression models with variance components a new generalized interval estimator for the variance component corresponding to the random factor in mixed linear models with two variance components were proposed. Statistical properties of the interval estimators were explored through simulation for a wide class of experimental designs with respect to their probability of coverage of the true, but unknown estimated parameter of variance (the variance component) and their expected length. We have suggested new approximate confidence region of the parameters in the Errors-In-Variables model which was directly applicable for the linear calibration problem. We have also suggested algorithms for finding the mode of multinomial distribution as well as for computing the distribution of a linear combination of independent t random

variables. The research was focused further on the interlaboratory comparisons methods that are an important part of metrology in determination of the key comparison reference value and the associated uncertainty. The interlaboratory experiments are frequently modeled by statistical mixed linear models, which include the fixed as well as the random effects. We have derived new interval estimators of the between-laboratory variance and of the comparison reference value. The simulation study approved that the new method performs better, especially in the case of small sample sizes.

Statistical properties of the goodness-of-fit tests for the Cauchy distribution and the nonparametric methods for multiple comparisons were studied and compared. A new modified quantile test was proposed which is better than the well-known Henze test, especially for sample sizes less than 50. Further, a multisample version of Lepage test based on ranks was proposed. The proof that the proposed test is asymptotically chi-square distributed under the null hypothesis and the derivation of its parameter of noncentrality in case of Pitman alternatives can be regarded as important theoretical results. It was proved that for normal distribution the asymptotic efficiency of the test with respect to the likelihood ratio statistic is 61%-95%, according to the nature of Pitman alternative. Also, a new nonparametric rule for multiple comparisons based on ranks permitting unequally sized samples from populations compared was constructed. Properties of nonparametric methods for multiple comparisons based on joint ranks as well as ranks obtained by pairwise ranking were explored by means of simulation.

New results have been derived for the Maximum Entropy method (MaxEnt), which belongs into the toolkit for solving ill-posed inverse problems. A probabilistic justification of the method was extended to the case of non-convex feasible set of probability mass functions. A concept of μ-projection, closely related to the Method of Maximum Probability was introduced and its relationship to I-projection was studied.

We have proposed and optimized new classification methods and algorithms for classification of image objects for the anti-doping software system GASepo for detection of the recombinant hormone erythropoietin. Synthetic and recombinant hormone erythropoietin (rEPO) is useful for therapy of diseases associated with a lack of native human glycoprotein EPO. This protein can be used as a doping substance, especially in endurance sports, where a performance increase up to 10% can be achieved. One particular problem was the automatic classification of the segmented image objects into two classes: bands and artefacts, respectively. The GASepo system was developed in the framework of the WADA (World Anti-Doping Agency) project by the Austrian Research Centers GmbH, Seibersdorf, Austria. The researchers of the Department proposed and implemented several classification algorithms for the problem. As the most efficient were selected the algorithms based on the method of neural nets, a new nonparametric method developed by Dr. F. Rublík and the generalized Fisher linear classifier. The algorithms were implemented in Matlab and evaluated according to their computational demands for implementation into the system GASepo. Further, improved image preprocessing method has been developed. The proposed method - Band Straightening Algorithm (BSA) - significantly reduces local geometric distortions in Epo images that cause band detection problems, especially incases with geometrically distorted and disrupted bands. The proposed method has been implemented in the latest release of the software package GASepo 2.1, which is used in Doping-Control laboratories worldwide.

The research of the Department was focused also on the area of human brain activity. Using methods of non-linear dynamics we have analyzed EEG data of three different types – whole-night sleep records, signals measured during relaxation, and data recorded during multiple repeating of 20-minute audiovisual stimulation (AVS). AVS is a simple method of brain stimulation by repeated monotonous audio and visual impulses. It is often referred to as a therapeutic tool for correction of some mental and neurological diseases. The objective of the research was to investigate direct, transient, and long-term effects of

AVS. We have characterized the EEG during long-term regular use of AVS and found consistent increase of spectral power in a lower frequency range (4 – 10 Hz). This phenomenon, known from neurophysiology, is a sign of an onset of relaxation. Other indicators of relaxation (e.g. increased synchronization between hemispheres) turned to be impugnable. The audiovisual brain stimulation in general was shown to produce measurable effects as e.g. clear increase of the overall power in the central right hemisphere, higher coherence in alpha-1 spectral range, and decrease of correlation dimension. The results of this research contributed to the objective quantitative characterization as well as better clarification of the state of relaxation. During this research, we have also analyzed the whole-night EEG sleep records (provided by Prof. G. Dorffnerom, Siesta Group Schlafanalyse GmbH, Austrian Research Institute for Artificial Intelligence, Vienna, Austria). We have shown that some characteristics known from the chaos and fractal theory, tested in a context of attention decrease, falling asleep, and sleep stages alternation surpass classification and prediction abilities of traditional spectral methods. Our actual results anticipate a presence of scale-invariant, fractal-like structures in EEG data. As a source of these structures description by stochastic system of 1/f noise type is preferred to the hypothesis of deterministic chaos. The selected measures have potential to contribute for clinical neurophysiology, in design of brain–computer interfaces, and in other applications that require detecting subtle changes of brain activity.

Since 2006 the research team is involved in the EU project BAMOD - Breath-gas analysis for molecular-oriented detection of minimal diseases, a project within the framework of the specific research and technological development programme integrating and strengthening the European Research Area. There is strong evidence that particular cancers can be detected by molecular analysis of exhaled air. Breath analysis represents a new diagnostic technique that is without risk for the patient even if repeated frequently and can provide information beyond conventional analysis of blood and urine. Recent results suggest that detection of different kinds of cancer is possible by means of breath analysis in very early stages of the disease. This project is focused on the diagnosis of minimal disease and early stages of lung and oesophageal cancer. The analytical techniques are based on gas chromatography with mass spectrometric detection (GC-MS), proton transfer reaction mass spectrometry (PTR-MS), selected ion flow tube mass spectrometry (SIFT-MS), laser spectrometry and ion mobility spectrometry (IMS). The Institute of Measurement Science is responsible for development of statistical algorithms for data analysis of breath gas concentration measurements, in particular, for processing of non-normal distributions of measurement results (higher-order moments and different variances may play a role), performing multiple comparisons (corresponding to different cancer stages and different control groups), and for establishment of typical patterns in high-dimensional phase spaces (due to consideration of many different substances), establishment of (possibly nonlinear) projection methods from high-dimensional phase spaces to 2- or 3-dim subspaces for visualization. During the period of the first 12 month of the BAMOD project we have developed a first version of the Matlab toolbox for statistical analysis of concentration measurements of volatile organic compounds in human breath gas for potential detection of primary lung cancer, based on the PTR-MS measurements.

Research in the Department of Imaging Methods was aimed at solving problems of imaging of biological and physical objects using nuclear magnetic resonance (NMR) at the magnetic field of 0.1 T and using CT (X-ray based tomography). The main goal of the research were new imaging methods, special sensors, whole-body imaging and micro-imaging.

VEGA and Eureka projects and State program of research and development project supported basic research of imaging based on nuclear magnetic resonance by ultra-low magnetic field in the range of 10 – 100 mT. The main topics in this field included research

of signal/noise measurements by low magnetic fields and border conditions estimations of the basic magnetic field and RF field, study of measuring sensors parameters with integrated configurations based on new technologies, resonators at room and cryogenic temperatures and creation of conditions for NMR-SQUID probes application. Methods and algorithms for measurement and imaging of thin layers of biological and non-biological samples, for progressive optimisation of stationary, gradient and RF magnetic fields and for image processing using adaptive wavelet transform in pre-processing of NMR signals in the k-domain were investigated. Methods for the quasi-continuous distribution of the relaxation times providing information about subvoxel parameters of the measured object in bulk were studied and possibilities of measurement by low magnetic fields, basic magnetic field and RF field imaging and sequences for basic magnetic field inhomogeneities measurement, setting and testing for the whole-body experimental NMR scanner TMR 96 were investigated. Possibilities of imaging using ferrofluids as contrast media and preparation and testing of nanoparticles ferrofluids were studied and ability to increase contrast of MRI by employing superparamagnetic nanoparticles that change the rate at which protons decay from their excited state to the ground state was studied. Effects of magnetic susceptibility in Magnetic Resonance Imaging were simulated, numerical model-based method for the evaluation of magnetic inhomogeneities impact on the MR image was developed and model for 3D MRI, spectroscopic, diffusion and relaxometric sequences was generalized. Methods with surface rendering for higher accuracy in the case of special geometries were developed.

International aspects and incorporation of this research into the ERA are documented by the main partners that were Universität Wien, Medical School, Austria, Institute of Nuclear Research of the Hungarian Academy of Sciences, Debrecén, Hungary, Unité de Recherche en Résonance Magnétique, Université Paris-Sud, France, Department of Oncology, Radiology and Clinical Immunology, Uppsala University Hospital, Uppsala, Sweden, and Dipartimento di Biochimica, Biofisica e Chimica delle macromolecole Universita degli studi di Trieste, Italy. This research created base for integration into the projects of the 6th Framework Program.

National importance of the research is underlined by building the Centre for NMR Based Material Imaging in the Institute as a part of the National centre of NMR – centre of excellence. Main goals of the centre will be education of experts for NMR based measuring systems, technical as well as postdoctoral-study-based scientific, function of an initialization centre for new products and technologies support, support of research and development projects solving (own projects, local and international projects, technical services for other projects) and support of activities of other research centers and projects (centers of excellence).

Imaging based on NMR by ultra-low magnetic field 100 mT and preparation for application of NMR He3 imaging including research of physical possibilities, instrumentation and methods was investigated within an Agency for research and development support project and starting project of the EU 6th Framework Program "Maria Currie" PHELINET (Polarized Helium Lung Imaging Network). It aims at wide and rapid dissemination of the hyperpolarized (HP) Helium3 lung MRI technique, through a pan-european cooperation of 11 academic and 6 industrial partners. It focuses on realization of this technique for lung diseases diagnostic and for evaluation of therapy efficacy and on the development of efficient and robust methods and tools for HP He3 lungs MRI.

Kit of digital radiological system of a new generation was developed within a project of the Agency for research and development support, APVV. It was focused on design, construction and verification of a digital radiological system of a new generation with energetic separation of detected photons, with X-ray source having a small focus (in order of 10 μm) and with automatically controlled positioning for scanning and tomography. Result contains user software equipment for acquisition, processing data

and depicting X-ray frames. Mathematical routines make possible tomographic reconstruction, filtering the data and editing the final image. Detecting unit based on monolithic GaAs X-ray sensors with direct conversion (period of 250 μm or less) works in so-called quanta regime. Electronic readout can separate protons into minimal 2 automatically selected levels. Part of the kit is X-ray source equipped with collimator, filters and automatically controlled aperture shutter. The purpose of the kit is realization of built-in and mobile modifiable customer radiological systems with positioning making possible scanning and tomography.

Automated Electronic System for Experiments with Stress Loadings by Hypergravitation project used the centrifuge device for hypergravity simulation in gravitational physiology experiments with animals. Group of animals were exposed to hypergravity by using the centrifuge device and simulating a gravity load up to 6g. The blood samples from tested animals obtained during the experiments were used for analysis of influence of the gravitation force on the animal organism. The radiofrequency remote control block of automated blood withdrawal system was developed and short time (up to two hours) and the long time experiments (up to one or two weeks) were performed on this device and compared to a reference group of animals placed on the floor of the centrifuge room for comparison where only the stress factors (noise and vibration of the device, light, and temperature) had influence, not the gravitation force. The project succeeded in developing an electro-mechanical equipment of the centrifuge device that will be used for study of microgravity effect of experimental animals during the space flight and for understanding changes of mechanism of the neuroendocrinal system and metabolic process. First experiments with the animals were successfully realized. The project was monitored by Slovak Commission for Research and Peaceful Uses of Space at The Council for Science and technology of Government of Slovak Republic.

Education of PhD students and scientific workers for research, development, innovation, and application in measurement science was organized within a project supported by the European Social Fund. It guarantees highest quality of the PhD and post-doctoral study under guide of top specialist in authorized scientific disciplines. Partners of the project were Faculty of Mechanical Engineering, STU Bratislava and Faculty of Electrical Engineering and Information Technology STU Bratislava. For the Institute of Measurement Science SAS 5 new PhD students with full compensation their scholarship and further expense have been admitted.

Scientific research in the Department of Biomeasurements has been oriented to research of measuring methods and devices for biology and medicine. Using models of measured objects, new methods for biosignals measurement and evaluation have been searched and possibility of their use for non-invasive assessment of the state and characteristics of selected biological objects has been analyzed. Multichannel measuring devices have been developed to enable application of proposed methods in biomedical research and in medical diagnostics and therapy.

Within the assessed period, the research in the Department was focused on

- modelling of the electrical activity of the human myocardium under normal and pathological conditions,
- research of signal processing and inverse methods for non-invasive assessment of selected pathological states of organs (namely of heart and stomach) from measurements of their electrical activity,
- dedicated biomedical measuring systems have been developed for diagnostics of heart, stomach and thyroid gland functions based on analysis of multiple biosignals.

Models of the heart and torso as an inhomogeneous volume conductor have been developed and processes of cardiac depolarization and repolarization and generation of cardiac electric field in the torso were modelled. The heart models include analytical or realistic definition of the ventricular myocardium with conduction system, excitation

propagation was governed by cellular automaton, potentials in the chest were computed using boundary element method and equivalent cardiac generator represented as homogeneous dipole layer or multiple dipole. The research implied evaluation of the sensitivity of developed models to errors in measured data. Models were used for forward ECG simulation and as a part of methods for inverse identification of selected cardiac pathologies.

A method for non-invasive assessment of myocardium with changed repolarization in case of local ischemia was proposed. It uses multichannel ECG measured with and without manifestation of the changed repolarization. From the topographic information of changed time integrals of ECG signals characterizing the myocytes action potentials in different areas of the myocardium and from torso structure and geometry, equivalent electrical dipole corresponding to the changed repolarization can be estimated and localized. Possibilities of the method were tested in computer simulations. They showed that for small lesions (up to 8% of the myocardium) in practical situations (62 measured ECG leads, standard deviation of ECG integrals less than 2 mV.ms) the lesion localization error does not exceed 1.5 cm and the dipole orientation 20°. Method was experimentally tested on a group of 11 patients that underwent cardiac intervention on single coronary vessel. In 8 patients the repolarization changes could be approximately represented by a single dipole, in 7 of them the affected area was identified in the expected part of the myocardium even though only standard chest geometry was used. Testing on a large group of patients from Dalhousie University where acute ischemia was induced by single artery closing revealed that using standard chest geometry resulted in overlaying of identified affected locations but with characteristic orientations of the estimated dipoles for 3 main coronary vessels.

High resolution multi-channel measuring system for body surface potential mapping was developed. They use active electrodes, 22/bit σ-Δ converters for each channel and optical USB interface to controlling PC. It can be used for non-invasive diagnostics of selected cardiac diseases based on potential and integral maps, including the above mentioned method.

In the research of electrogastrographic measurements, methods for time-frequency analysis of measured EGG signals were used and their application for monitoring of the stomach motility was investigated. Non-stationary time frequency analysis using Wigner transformation with Choi-Williams filtering proved to be able to detect the dynamics of EGG signals and to monitor changes in newborns, in patients with diabetic gastro paresis or after operations of the gastric tract.

Advanced methods for processing of noisy EGG signals were studied in order to extract useful information from real EGG measurements. Model analysis of signals with different types of disturbances showed the possibility to use blind source separation to separate signals from multiple sources using independent component analysis (ICA). This method was successfully used for separation of disturbances from external technical sources as well as from electrical sources in different organs

Intelligent device for multichannel EGG measurement and signal analysis was developed and offered to cooperating medical partners. It enables long term monitoring of EGG signals with several automatically controlled measuring parameters and their recording in a PC connected over the Ethernet or serial interface. The device enables to detect basic ECA (Electrical Control Activity) with frequencies below 0.1 Hz (typically 3 cycles/minute) as well as ERA (Electrical Response Activity) in the range to several Hz. Using the device, new results about the relation between the gastric electric activity and stomach structure and function were obtained in animal experiments (nutrition changes, medication) and in measurements on humans (newborns, patients with functional dyspepsia).

Concept of distributed measuring system BioLab for experimental and clinical biosignal measurements has been proposed. The system consists of independent intelligent sensors connected over the Ethernet network to a controlling computer. In individual sensing modules particular biophysical methods can be implemented. Two examples of such modules are BioLab ATR module for optoelectronic measurement and evaluation of Achilles tendon reflex (ATR) time intervals and BioLab STI module for recording of systolic time intervals (STI) extracted from ECG, carotidogram and phonocardiogram. Parameters from neuromuscular and cardiovascular system obtained by these modules can be used as peripheral indicators for noninvasive monitoring of the thyroid gland function. The method and devices are being tested in cooperation with medical partners in Slovakia and Czech Republic.

The above mentioned research was organized within national and international projects. Department has cooperated with research partners in Slovakia and abroad, e.g. with Institute of Normal and Pathological Physiology SAS in Bratislava in modelling of the myocardium excitation, with National Institute of Cardiovascular Diseases in Bratislava in application of proposed methods for noninvasive cardiac diagnostics, with Institute of Pathological Physiology, School of Medicine, Comenius University in Bratislava in research and application of methods for gastric electric activity evaluation, with Institute of Technical Physics and Materials Science CRIP HAS in Budapest, Hungary, Institute for Information Transmission Problems RAS in Moscow, Russia, Institute of Biocybernetics and Biomedical Engineering PAS in Warszawa, Poland and Dalhousie University, Halifax, NS, Canada in comparing different approaches to model-based evaluation of the cardiac electric field and exchanging experimental data, with Faculty of Biomedical Engineering, CTU in Prague, Czech republic in development of new biomedical devices.

3. Concept of R&D activity of the Organisation for the next four years (max. 5 pages)

The concept of research and development activities of the Institute of Measurement Science for the next four years (2007-2010) is aimed at high-quality basic research, focused on design of methods and measuring systems dedicated to non-standard measurement problems in technical and biomedical research and industry, in accordance with the Foundation Charter of the Institute, by advancing measurement science in ways that could help to enhance the national technical and industrial competitiveness and improve quality of life.

The Institute's research activity during the period 2007-2010 will be (in accordance with national scientific priorities and the priorities of the EU Framework Programmes) focused on development of advanced non-destructive and/or non-invasive measurement methods for scientific, technical and biomedical applications. In particular, the research of the Institute will be focused onto the following areas:

- measurement science, including development of the mathematical, statistical and computational tools and algorithms necessary for the fundamental understanding of the measurement systems and processes, and methods for evaluation of measured data
- new materials, technologies and methods for advanced measurement devices, including SQUID magnetometric methods based on low-temperature superconductors and material research focused on high-temperature superconductors
- non-destructive contactless diagnostics in technical research and industry (NMR tomography, optical methods), including digital radiological imaging systems of a new generation in non-destructive material research, microelectronics, microtomography, coherence optical tomography and optoelectronic methods for non-destructive measurement and testing, and magnetometric methods

- non-invasive diagnostics in biomedicine, including high-resolution lung magnetic resonance imaging using hyperpolarized Helium3 gas, research and development of non-invasive magnetometric methods for examination and diagnostics of lung and liver diseases, methods and algorithms for breath gas analysis for early detection of lung cancer, methods and devices for modelling, measuring and evaluating the electric activity of biological systems (ECG, EGG, EEG).

These activities are a natural extension of the current research projects and scientific experience (based on broad national and international cooperation) of the Institute's research staff, scientific departments, and its Centre for non-standard measurements, a joint science and technology department with two Faculties of the Slovak Technical University.

i. Present state of knowledge and status of ongoing research related to the subject of the Concept, from both international and national perspective

MEASUREMENT SCIENCE

Technical and biomedical measurements and their evaluation are based on the theory of the measured object, the theory of the measuring system and on the mathematical and statistical methods for evaluation of the measurement results. The Institute will contribute to the development of appropriate methodology focused in particular on the methods of the mathematical statistics and applied mathematics.

Future research will be aimed at methods for analysis of measurements with small number of observations (very often with outliers, heteroscedasticity is typical and observed values do not fulfill the classical assumption of normal distribution) the situation motivated e.g. by the current EU project BAMOD (measurements are obtained by a few different types of mass-spectrometers: GC-MS, PTR-MS, SIFT-MS, laser-spectrometry, IMS). Also models and methods for metrological applications will be developed (calibration models, multiple comparisons models, determination of uncertainties of measurement results, confidence and tolerance intervals). The following research areas are of main interest:

- optimal procedures for statistical inference (point and interval estimation of parameters, tests of hypotheses, predictors) in linear mixed models (models with fixed and random effects) for small sized samples,
- development of methods of statistical inference for models with nuisance parameters,
- non-parametric models and methods,
- methods for estimation of parameters and testing of hypotheses in nonlinear models, e.g. methods based on the analysis of properties of I-divergence.

An open issue, motivated by acute needs of metrological and biomedical applications (interlaboratory comparisons, meta-analysis, evaluation of biomedical trials), is development of new procedures for estimation and testing in replicated model with heteroscedastic errors, which can be considered as a special case of a linear mixed model.

Future research will be also focused on application of nonlinear dynamical systems methods and mathematical statistics to the analysis electroencephalographic signals (EEG). The objective lies in investigation of the dynamical states of EEG and the design of original algorithms, which are capable to characterize and predict specific brain states (attention decrease, sleep stages). The results may be applicable in neuro-diagnostics, therapy as well as in design of effective strategies of attention control.

NEW MATERIALS, TECHNOLOGIES AND METHODS FOR ADVANCED MEASUREMENT DEVICES

The material research focused on high-temperature superconductors (HTS) will continue during the period 2007-2010. Despite the fact that almost twenty years have passed

since the discovery of the high-temperature superconductivity (HTS), in a new class of copper-based materials (cuprates) up to now, there is no generally accepted theory reasonably explaining all experimental results. All cuprates are layered systems having the same basic crystallographic structure. It is generally believed that it is the layered structure of the materials that leads to intrinsic network of Josephson junctions (JJs). The existence of the intrinsic JJs that are characterized by the Josephson nonlinear electric current-magnetic flux relation and strong dependence on doping make these materials very interesting for measuring technique. In addition, many interesting future industrial applications are being laboratory prepared and tested: superconducting motors, generators, current protective switches, magnets, energy storage systems levitation transportations, bearings, etc.

Several unique measuring devices will be implemented and improved, necessary to analyse properties of HTS, development of new materials and SQUID magnetometric methods. In the area of SQUID magnetization measurements, the 3rd gradiometer based on low-temperature superconductors will be constructed and tested within the framework of the system for measuring magnetization properties of HTS in order to suppress effects of noise signals in measurements of magnetic characteristics of HTS. During the next years, we also want to pay attention to laser SQUID-microscopy and magneto-optical (MO) method of mapping magnetic fields. We have developed our own technology and prepared samples of synthetic yttrium-iron (Bi: YIG) garnet doped by bismuth suitable also as targets for the production of a TF indicator by a magnetron sputtering technique. Possibilities of the use of terbium-gadolinium garnet in the function of the MO indicator will also be reviewed. In addition, attention will be paid to the interface and software.

NON-DESTRUCTIVE CONTACTLESS DIAGNOSTICS IN TECHNICAL RESEARCH AND INDUSTRY

Optical frequency stabilisation of diode lasers. Development of diode laser stabilised by saturated absorption in vapour of Rb 85 or Rb 87 rubidium atoms at the wavelength of 778 nm by two-photon transition 5S1/2-5D5/2. Until now only several laboratories in the world succeeded in the development of such stabilised lasers. Research results can be applied in the length metrology.

Infrared thermometry and thermography. Development of new non-destructive methods based on the active infrared thermography for testing of invisible subsurface defects and inhomogeneities. This research topic is well suited to the European strategic research in the field of non-destructive testing and has a great importance to improve the quality of industrial products.

Optical methods in non-destructive contactless testing. Theoretical analysis, development and application of optical non-destructive methods for surface and subsurface testing - near infrared reflectography, active thermography, optical coherence tomography, ultraviolet fluorescence. Contemporary all these methods are being massively developed in many R&D establishments abroad but there is domestic gap of these methods. Results of the research will be applicable in materials research, industry, work of art restoration, as well as in security applications which are one of the actual priorities of the EU framework program.

Development of new electronic measuring systems for experimental relativistic physics. This project will be conducted in the frame of international scientific collaboration with the Laboratory of high energies of the Joint Institute for Nuclear Research in Dubna, Russia. Research will be focused on the development and improvement of the basic experimental equipment of JINR devices for measurement of extracted particle beams of Nuclotron accelerator.

Optoelectronic methods of vertical axis drift measurement and earthquake detection systems for large-scale objects (nuclear power stations, river dam).

Digital radiological imaging systems of a new generation. The system based on using a method of energetic separation of single detected photons with X-ray source having a small focus (in order of 10 μm) and with automatically controlled positioning for scanning and tomography. Detecting unit based on monolithic GaAs X-ray sensors with direct conversion (period of 250 μm or less) works in so-called quanta regime. Electronic readout can separate protons into minimal 2 automatically selected levels. Part of the kit is X-ray source equipped with collimator, filters and automatically controlled aperture shutter. This new technology will be aimed to the realization of built-in and mobile modifiable customer radiological systems with positioning making possible scanning and tomography. Application is in non-destructive material research, microelectronics, microtomography, high-resolution imaging in biology and medicine.

Nuclear magnetic resonance imaging is focused on the basic research of selected imaging methods, in particular, the study of porous media using the NMR phenomenon, research in the domain of measurement by low magnetic fields, stationary magnetic field and RF field imaging, study of imaging using ferrofluids as contrast media, preparation and testing of nanoparticles ferrofluids, research in the field of magnetic susceptibility effects in Magnetic Resonance Imaging. These aspects are following the latest scientific and technological development in the direction of non-destructive material defectoscopy, nanotechnology layers detection and imaging, susceptibility measurements and imaging of thin layer biological and non biological materials.

NON-INVASIVE DIAGNOSTICS IN BIOMEDICINE

Biomagnetic diagnostic methods will be focused on biomagnetometric susceptometry of the liver. A new contactless method and design of systems for magnetic measurement of iron content in the liver (magnetic biopsy) will be designed. For this purpose, a specialized SQUID magnetometric system will be developed. We will analyze possible new correlations between the diseases (risk states) of the liver and the iron content in it. The research of metabolism and iron accumulation in a human organism, specifically in liver attracts significant attention mainly in terms of the development of non-invasive methods. Such type of research is of current interest in several world workplaces (e.g. FFCLRP-USP Sao Paulo, Brazil, G.D. Annunzio University, Chieti, Italy, National Institute for the Physics of Matter, Italy, University Hospital Hamburg-Eppendorf, Germany, Tristan Technologies, Inc., San Diego, USA). Iron is necessary in oxide-reduction reactions and various types of catalysis for all cells but in higher levels, it may also be toxic, as it has a tendency to form oxygen radicals, which destroy cells. The method will be directly applicable to diagnostics and continuous monitoring of diseases in patients with an increased Fe level in liver.

Magnetic resonance imaging methods for diagnostics of respiratory diseases. Respiratory conditions impose a huge burden on society. The top five respiratory diseases account for 17.4% of all deaths and 13.3% of disability-adjusted life years. Chronic obstructive pulmonary diseases have become the fourth cause of death worldwide whereas lung cancer, lower respiratory track infections and tuberculosis are among the 10 leading causes. Asthma draws somewhat less attention than other respiratory conditions due to its low fatality rate, but affects about 150 million people worldwide and is the most prevalent chronic disease in childhood. Diagnosis of lung diseases has traditionally relied on imaging techniques like plain chest radiography, high resolution computed tomography (CT) or lung scintigraphy. Inherent patient exposure to ionising radiation limits the extensive use of these techniques, and excludes repeated use for accurate follow-up of the evolution of the disease and of the response to treatment or surgery. High-resolution lung magnetic resonance imaging (MRI) can now be performed using hyperpolarized (HP) Helium3 gas as an inhaled magnetic tracer. HP Helium3 lung MRI starts to compete with routine diagnostic tests, providing both a spatial resolution now similar to that of CT and better than that of lung scintigraphy, and a temporal resolution that outperforms both CT and scintigraphy.

Non-invasive inverse methods for electrocardiologic diagnostics using model-based interpretation of multilead surface potentials and knowledge of the electrical and geometrical structure of the chest obtained from imaging techniques are recently termed as electrocardiographic imaging. With availability of necessary technologies, this approach can essentially improve the electrocardiographic diagnostics in the near future. Similar development is noticeable in the diagnostics of other organs generating measurable bioelectric fields, e.g. brain and stomach. Further research of forward models included in the inverse solution is desirable as documented by the Europhysiome project that will combine all European Physiome projects, among them the Cardiome project which aims to develop a large scale computational model of the beating heart, from a gene to the whole organ level. It induces development of advanced biosignal processing methods and multimodal measuring systems with possible application to telemedicine.

ii. Organisation's role or significance in the overall research effort within the field of the Concept on both the national and international scales

The Institute has significantly contributed to several research domains enumerated in the Concept of R&D activity both at the national and international scale. Research activities of the Institute are well incorporated into the research activities of the European research area (EU Framework Programmes, COST, EUREKA) and accepted by international scientific and professional societies (IMEKO, IFMBE, IEEE, SPIE, ICE). On national level, wide cooperation exists with SAS institutes, universities, and important industrial partners, cultural and healthcare institutions. The Concept is based on a natural combination of the current and recent research experiences from the national and international projects and the scientific potential of the Institute's departments as well as its Centre for non-standard measurements.

iii. Objectives of the Concept

The objective of the Concept is to provide high-quality basic research focused on the design of methods and measuring systems dedicated to non-standard measurement problems. This objective is based on the scientific experience of the Institute's research staff (which includes researchers experienced in mathematics and physics, information and engineering technologies, and engineers as well as the production unit) and on national and international scientific cooperation. The following particular goals are primary objectives of the Concept:

- research of new optimal statistical procedures for inference in linear and nonlinear models with complicated covariance structure,
- development of a new optical frequency stabilisation of diode lasers by saturated absorption method, new methods for infrared thermometry and active thermography, investigation of optical non-destructive methods and optical coherence tomography systems for surface and subsurface testing and development of an electronic measuring systems for experimental relativistic physics,
- research on high-temperature superconductivity and the development of technological procedures for a reproducible preparation of precursors, sintered, textured and monodomain superconducting materials based mainly on REBaCuO compositions,
- development of magnetometric methods for non-invasive examination and diagnostics of liver diseases - magnetic biopsy of liver (MBL), development of an experimental SQUID measuring system for MBL, determination of magnetic substances mass concentration in various large-volume objects, definition of biological factors influencing the rate and determination of the correction factors and

comparison of the methods using the DC and AC magnetization field on the liver samples in vitro,

- development of measuring techniques based on NMR of specific organs of a living organism by utilization of biologically neutral magnetic liquids, development of techniques for relaxation times measurement of biological materials,
- development of imaging methods oriented to defectoscopy of materials from the point of view of their structure and physical features investigation,
- research of new model-based measuring methods and development of devices for non-invasive assessment of the electrophysiological state of biological systems.

iv. Proposed strategies and methods to be applied, and time schedule

The Institute's research activity during the 2007-2010 period will be oriented on topics implied by national scientific priorities as well as the priorities of the EU Framework Programmes. In order to fulfill the planned targets, it will be strategically important to obtain adequate support from national grant agencies – the Slovak Research and Development Agency (APVV) and the Scientific Grant Agency of the Ministry of Education of Slovak Republic and the Slovak Academy of Sciences (VEGA), and from the EU Framework Programmes (FP6 and FP7) and structural funds. Currently, the Institute is a research partner in 2 supported FP6 projects (Bamod and Phelinet), 3 national APVV projects, and 8 VEGA projects. The support from the EU structural funds (2007-2013) is hoped to significantly improve the Institute's research and laboratory infrastructure in near future.

The Institute will continue and widen its scientific co-operation with focus on themes that could lead to common project proposals, with priority given to the Seventh Framework Programme and the national APVV projects.

III. Partial indicators of the main activities:

1. Research output

i. List of the selected publications documenting the most important results of basic research. Total number of publications in the whole assessed period should not exceed the average number of the research employees

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[36] MIČUNEK, R. - PLECENIK, A. - KÚŠ, P. - ZAHORAN, M. - TOMÁŠEK, M. - PLECENIK, T. - GREGOR, M. - ŠTEFEČKA, M. - JACKO, Vlado - GREGUŠ, J. - GRANČIČ, B. - KUBINEC, M. - MAHEĽ, M. Preparation of MgB_2 superconducting thin films by magnetron sputtering. In *Physica C : Superconductivity and Its Applications.* ISSN 0921-4534. Vol. 435 (2006), p. 78-81. (0.948 – IF2005)

[37] ŠTOLC, Svorad - BAJLA, I. Improvement of band segmentation in Epo images via column shift transformation with cost functions. In *Medical and Biological Engineering and Computing : Journal of the International Federation for Medical and Biological Engineering*. ISSN 0140-0118. Vol. 44, no. 7 (2006), p. 605-607. (1.028 – IF2005).

[38] TEPLAN, Michal - KRAKOVSKÁ, Anna - ŠTOLC, Svorad. EEG responses to long-term audio-visual stimulation. In *International Journal of Psychophysiology*. ISSN 0167-8760. Vol. 59 (2006), p. 81-90. (2.584 – IF2005)

[39] TIŇO, P. - FARKAŠ, Igor - MOURIK, J.M.V. Dynamics and topographic organization of recursive self-organizing maps. In *Neural Computation*. ISSN 0899-7667. Vol. 18 (2006), p. 2529-2567. (2.591 – IF2005)

[40] AIDU, E.A.. TRUNOV, V.G.. TITOMIR, L.I.. TYŠLER, M.. TURZOVÁ, M. Szathmáry, V.: Electrocardiographic ST segment changes as an indicator for localization of injury potentials. A computer simulation study. Kardiology, Vol.15(1), 2006, 21-24. ISSN1210-0048, ISSN 1336-2429.

[41] ZRUBEC, Vladimír - MAŇKA, Ján. Sensitivity of superconducting quantum RF magnetic field receivers for NMR spectroscopy and tomography. In *Physica C : Superconductivity and Its Applications*. ISSN 0921-4534. Vol. 435 (2006), p. 132-135. (0.948 – IF2005)

ii. List of monographs/books published abroad

Chapters in monographs

[1] GRENDÁR, Marian. Conditional equi-concentration of types. In Velle, L.R. *Focus on Probability Theory*. New York : Nova Publishers, 2006. ISBN 1-59454-474-3. P. 73-89.

[2] A.P. ACCARDO, I. STROLKA, R. TOFFANIN, F. VITTUR: Techniques in the medical imaging analysis of the three dimensional (3D) architecture of trabecular bone and their applications. In Medical Imaging Systems Technology: Methods in General Anatomy, (vol.3), World Scientific Publishing Company, pp 1-41, 2005. ISBN-10: 981256991X ISBN-13: 978-9812569912

iii. List of monographs/books published in Slovakia

0

iv. List of other scientific outputs specifically important for the Organisation

In accordance with the Foundation Charter of the Institute, its mission includes design of methods and measuring systems dedicated to non-standard measurement problems in the research and industry. Most important outputs of this type were

[1] For the Joint Institute for Nuclear Research in Dubna, Russia apparatus for distributed measurement and evaluation of geometrical parameters of particle beam and a new method and electronic control system to control the magnetic field in the Nuclotron accelerator were developed and built.

[2] For the Czech Technical University in Prague, Faculty of Biomedical Engineering, Kladno high resolution multichannel measuring system was developed and built for measurements of biosignals in heart and brain research.

[3] For the experiments within cosmic research in the Institute of Experimental Endocrinology and Institute of Animal Biochemistry and Genetics SAS, IMS participated in research, development and construction of the centrifuge telemetric control, video monitoring system, electronic equipment for automated multiple blood withdrawal from experimental animals and several another measuring blocks used in the physiological research of micro- and hypergravitation.

[4] For the Institute of Pathological Physiology, School of Medicine, Comenius University in Bratislava experimental system ProGastro for electrogastrograms measurements in animal experiments and in humans was developed and built and dedicated biosignal processing methods were implemented.

[5] For two Slovak nuclear power plants (Jaslovske Bohunice, Mochovce) automated measuring systems for monitoring of the vertical stability and base wafer leveling of reactors were proposed and built.

v. Table of research outputs

*Table **Research outputs** shows research outputs in number of specified entries; these entries are then divided by FTE employees with a university degree (from Tab. Research staff) for all Organisation at the respective year; finally these entries are divided by the total salary budget (from Tab. Salary budget).*

Research outputs	2003			2004			2005			2006			total			
	number	No. / FTE	No. / salary budget	number	No. / FTE	No. / salary budget	number	No. / FTE	No. / salary budget	number	No. / FTE	No. / salary budget	number	averaged number per year	av. No. / FTE	av. No. / salary budget
chapters in monographs, books published abroad	0	0,00	0,00	0	0,00	0,00	4	0,12	0,26	1	0,03	0,06	5	1,3	0,04	0,08
chapters in monographs, books published in Slovakia	0	0,00	0,00	0	0,00	0,00	2	0,06	0,13	0	0,00	0,00	2	0,5	0,01	0,03
CC publications	15	0,47	1,00	6	0,17	0,39	8	0,24	0,51	8	0,22	0,51	37	9,3	0,27	0,60
scientific publications indexed by other databases (specify)	0	0,00	0,00	0	0,00	0,00	3	0,09	0,19	9	0,25	0,57	12	3,0	0,09	0,20
scientific publications in other journals	34	1,06	2,27	10	0,28	0,66	24	0,71	1,54	11	0,31	0,70	79	19,8	0,58	1,29
publications in proc. of international scientific conferences	33	1,03	2,21	19	0,54	1,25	38	1,12	2,43	18	0,51	1,15	108	27,0	0,79	1,76
publications in proc. of nat. scientific conferences	2	0,06	0,13	4	0,11	0,26	3	0,09	0,19	0	0,00	0,00	9	2,3	0,07	0,15
active participations at international conferences	52	1,63	3,48	41	1,16	2,70	61	1,80	3,91	43	1,21	2,74	197	49,3	1,44	3,21
active participations at national conferences	2	0,06	0,13	8	0,23	0,53	10	0,29	0,64	9	0,25	0,57	29	7,3	0,21	0,47

Other databases: INSPEC, ISI Proceedings, Index Copernicus International, MathSciNet, Zentralblatt MATH.

vi. Renormalized publications[2]

Renormalized publications = number of CC publications in the given year times authorship's portion of the Organisation times the journal impact factor in 2005 divided by the median impact factor in the research field

Renormalised publications	2003			2004			2005			2006		
	number	No. / FTE	No. / salary budget	number	No. / FTE	No. / salary budget	number	No. / FTE	No. / salary budget	number	No. / FTE	No. / salary budget
Renormalized publications	0	0,00	0,00	0	0,00	0,00	0	0,00	0,00	0	0,00	0,00

vii. Standard manuscript page count[3]

Standard manuscript page count	2003			2004			2005			2006		
	number	No. / FTE	No. / salary budget	number	No. / FTE	No. / salary budget	number	No. / FTE	No. / salary budget	number	No. / FTE	No. / salary budget
page count	0	0,0	0,0	0	0,0	0,0	0	0,0	0,0	0	0,0	0,0

viii. List of patents and patent applications

Patents:

[1] Morvová, M. - Morva, I. – Hanic, F. Spôsob spracovania exhalátov a zariadenie na vykonávanie tohto spôsobu. Patent č. 283 112. SR. Dátum nadobudnutia účinkov patentu: 4.2.2003. (Method of air pollutants processing and equipment for completion of this method; patent; effective since: 4.2.2003)

[2] Smrčka, P. – Hána, K. - Kašpar, J. - Kneppo, P. – Tyšler, M. Systém pre měření biologických a technických veličin v prostředí silného a proměnlivého elektromagnetického pole. Úžitkový vzor 17088. ČR (majiteľ: ČVUT v Praze FBMI, Kladno, CZ). Udelené: 12.12.2006. (System for measurement of biological and technical quantities in environment with strong and unstable electromagnetic field; design; owner: CTU in Prague, effective since 12.12.2006)

[2] This information is required only from the Organisations of the Section 2 of the Slovak Academy of Sciences.

[3] This information is required only from the Organisations of the Section 3 of the Slovak Academy of Sciences.

Patent applications:

[1] Hain, M. - Bartl, J. - Kur, J. – Kur, B. Spôsob vyhľadávania povrchových defektov najmä ložiskových krúžkov a zariadenie na vykonávanie tohto spôsobu. Prihláška vynálezu č. PP 272-2004. SR, 2004-09-07. (Method for searching of superficial defects particularly of bearing rings and and equipment for completion of this method)

[2] Andris, P. – Frollo, I. Spôsob merania fázy v NMR tomografii. Prihláška vynálezu č. PP 412-2004. SR. (Method for phase measurement in NMR tomography)

[3] Hain, M. - Bartl, J. - Kur, J. – Kur, B. Způsob vyhledávání povrchových defektů zejména ložiskových krožků a zařízení pro provádení tohto způsobu. Přihláška vynálezu č. PV2004-786. ČR, 2004-07-07. (Method for searching of superficial defects particularly of bearing rings and and equipment for completion of this method; in Czech republic)

[4] Smrčka, P. – Hána, K. - Kašpar, J. - Kneppo, P. – Tyšler, M. Systém pre měření biologických a technických veličin v prostředí silného a proměnlivého elektromagnetického pole. Prihláška vynálezu PV 2006-573. ČR. (System for measurement of biological and technical quantities in environment with strong and unstable electromagnetic field; patent application)

[5] ŠTOLC, S. - PENZ, H. - MAYER, K. - HEISS-CZEDIK, D.: Processing of intesinty values in distorted lanes (Epo doping-control). Austrian patent submission A833/2005. Department of High-Performance Image Processing, ARC Seibersdorf research, GmbH, Austria, 2005.

ix. Supplementary information and/or comments on the scientific output of the Organisation

The numbers of publications shown in the table “Research outputs” are in the same structure as in the annual reports, i.e. possible supplementary publications included in next year annual report were also counted in the next year. List of publication that did not appear in annual reports is shown in the document “Publications – Supplement” at our web page http://www.um.sav.sk/en/publications-and-citations/.

In years 2003-2006 authors from IMS SAS published additional 28 scientific papers in journals indexed in Current Contents that cover the topics of the research in the Institute. However, as the affiliation (name and/or address of IMS SAS) is not shown in these publications, they were not included in the tables.

2. Responses to the scientific output

*Table **Citations** shows specified responses to the scientific outputs; these entries are then divided by the FTE employees with a university degree (from Tab. Research staff) for all Organisation at the respective year; finally these entries are divided by the total salary budget (from Tab. Salary budget).*

Citations	2002			2003			2004			2005			total			
	number	No. / FTE	No. / salary budget	number	No. / FTE	No. / salary budget	number	No. / FTE	No. / salary budget	number	No. / FTE	No. / salary budget	number	averaged number per year	av. No. / FTE	av. No. / salary budget
Web of Science	50	1,6	3,3	54	1,5	3,6	72	2,1	4,6	62	1,7	4,0	238	59,5	1,7	3,9
Scopus	6	0,2	0,4	11	0,3	0,7	11	0,3	0,7	14	0,4	0,9	42	10,5	0,3	0,7
in monographs, conf. proceedings and other publications abroad	8	0,3	0,5	7	0,2	0,5	10	0,3	0,6	7	0,2	0,4	32	8,0	0,2	0,5
in monographs, conf. proceedings and other publications in Slovakia	2	0,1	0,1	18	0,5	1,2	3	0,1	0,2	11	0,3	0,7	34	8,5	0,2	0,6

i. List of 10 top-cited publications and number of their citations in the assessment period

[1] STADNIK, T.W. – CHASKIS, C. – MICHOTTE, A. – SHABANA, W.M. - VAN ROMPAEY, K. – LUYPAERT, R. – BUDINSKÝ, Ľ. – JELLÚŠ, V. – OSTEAUX, M. Diffusion-weighted MR imaging of intracerebral masses: comparison with conventional MR imaging and histologic findings. In *American Journal of Neuroradiology*. Vol. 22, 2001, p. 969-976. (67 WOS +4 SCOPUS)

[2] MATEJ, S. – LEWITT, R.M. Practical considerations for 3-D image reconstruction using spherically symmetric volume elements. In *IEEE Transactions on Medical Imaging*. Vol. 15, no. 1, 1996, p. 68-78. (26 WOS +8 SCOPUS)

[3] SRAMEK, M. – KAUFMAN, A.E. Alias-free voxelization of geometric objects. In *IEEE Transactions on Visualization and Computer Graphics*. Vol. 5, no. 3 (1999), p. 251-267. (7 WOS +11 SCOPUS)

[4] WITKOVSKÝ, V. Computing the distribution of a linear combination of inverted gamma variables. In *Kybernetika.* Vol 37 (2001), p. 79-90. (5 WOS +2 SCOPUS +1 other)

[5] COVA, M. – TOFFANIN, R. – SZOMOLÁNYI, P. – VITTUR, F. - POZZI-MUCELLI, R.S. – JELLÚŠ, V. – SILVESTRI, F. - DALLA-PALMA, L. Short-TE projection reconstruction MR microscopy in the evaluation of articular cartilage thickness. In *European Radiology*. Vol. 10 (2000), p. 1222-1226. (5 WOS)

[6] ROSIPAL, R. – KOSKA, M. – FARKAŠ, I. Prediction of chaotic time-series with a resource-allocating RBF network. In *Neural Processing Letters*. Vol. 7, no. 3 (1998), p. 185-197. (3 WOS +1 other)

[7] ZRUBEC, V. – CIGÁŇ, A. – MAŇKA, J. Simplified fast method for magnetic characteristics measurement of the HTc superconducting materials. In *Physica C*. Vol. 223, no. 1-2 (1994), p. 90-94. (2 WOS +2 other)

[8] WITKOVSKÝ, V. Exact distribution of positive linear combinations of inverted chi-square random variables with odd degrees of freedom. In *Statistics & Probability Letters*. Vol. 56 (2002), p. 45-50. (1 WOS +1 SCOPUS +2 other)

[9] BARTL, J. – FÍRA, R. – HAIN, M. Inspection of surface by the Moiré method. In Measurement Science Review, Vol. 1 (2001), p. 29-32. (3 WOS)

[10] ROSÍK, V. – TYŠLER, M. – TURZOVÁ, M. Portable device for ECG mapping. In *MEASUREMENT 1997 : International Conference on Measurement*. Bratislava : Institute of Measurement Science, SAS, 1997. P. 367-370. (3 other)

ii. List of top-cited authors from the Organisation (at most 10 % of the research employees) and their number of citations in the assessment period

[1] Vladimír Jellúš – 94 WOS + 9 SCOPUS

[2] Ľuboš Budinský – 69 WOS + 4 SCOPUS

[3] Samuel Matej – 36 WOS + 8 SCOPUS

[4] Viktor Witkovský - 11 WOS + 3 SCOPUS + 32 other

iii. Supplementary information and/or comments on responses to the scientific output of the Organisation

The number of citations shown in the table “Citations” is the sum of citations stated in the annual report of the next year plus supplements from the annual reports stated in following years plus possible newly found citations that were not shown in last four annual reports. The supplemented numbers of citations in assessed years are in brackets: 2002 (10); 2003 (14); 2004 (8); 2005 (8). Detailed list is shown in the document “Citations – supplement 2002-2005” at our web page http://www.um.sav.sk/en/publications-and-citations/.

3. Research status of the Organisation in the international and national context

- **International/European position of the Organisation**

i. List of the most important research activities documenting international importance of the research performed by the Organisation, incl. major projects (details of projects should be supplied under Indicator 4). Collective membership in the international research organisations, in particular within the European Research Area

[1] 6th FP STREP project "Breath-gas analysis for molecular-oriented detection of minimal diseases" (BAMOD)

[2] 6th FP, Maria Currie project "Polarized Helium Lung Imaging Network" (PHELINET)

[3] COST project COST "Non-destructive analysis and testing of museum objects"

[4] Eureka project "Low-field magnetic resonance imaging (MRI) for medical applications"

[5] Cooperation Science & Technology: Development of the accelerator facility NUCLOTRON, Russia (several projects)

[6] Collective membership in TEMPERE II (European Universities and Associations) coordinated by University of Patras, GREECE

Institute actively collaborates with several another International organizations (preparation of conferences, education, membership in committees). Despite there is possibility of collective membership in some of them, only individual membership of employees is practised mainly for financial reasons. Most important contacts are with:

[7] International Measurement Confederation IMEKO (Technical Committee on Education and Training in Measurement and Instrumentation - TC1, Technical Committee on Measurement Science - TC7, IMEKO Technical Committee on Measurement in Biology and Medicine - TC13)

[8] Institute of Electrical and Electronic Engineering IEEE (Instrumentation and Measurement Society, Engineering in Medicine and Biology Society, Magnetics Society)

[9] Bernoulli Society for Mathematical Statistics & Probability

[10] The International Society for Optical Engineering SPIE

[11] The International Federation for Medical and Biological Engineering IFMBE

[12] The International Union of Radio Science URSI

[13] International Society of Electrocardiology

ii. List of international conferences (co-) organised by the Organisation

[1] MEASUREMENT 2003 : 4th international conference on measurement. Smolenice, Slovak republic, June 15-19, 2003.

[2] MEASUREMENT 2005 : 5th international conference on measurement. Smolenice, Slovak Republic, May 15-19, 2005.

[3] Workshop COST G8 : in-situ non-destructive analysis and testing of museum objects. Bratislava, Slovak Republic, 15th April, 2005.

[4] PROBASTAT 2006 : the fifth international conference on probability and mathematical statistics. Smolenice Castle, Slovak Republic, June 5-9, 2006.

[5] XXIX Dni lekárskej biofyziky (XXIXth Days of Medical Biophysics): ExpoClub Incheba, Bratislava, May 16-18, 2006.

iii. List of international journals edited/published by the Organisation

[1] MEASUREMENT SCIENCE REVIEW, Journal of the Institute of Measurement Science, Slovak Academy of Sciences, Supported by Slovak National Committee IMEKO. Bratislava, ISSN 1335-8871, http://www.measurement.sk. (Index Copernicus International Database, http://journals.indexcopernicus.com/)

iv. List of edited proceedings from international scientific conferences and other proceedings

[1] FROLLO, Ivan (editor) - TYŠLER, Milan (editor) - PLAČKOVÁ, Anna (editor). *MEASUREMENT 2003 : 4 th international conference on measurement*. Bratislava, Slovakia : Institute of Measurement Science, SAS, c2003. 513 s. ISBN 80-967402-6-1.

[2] PŘIBIL, Jiří (editor). *MECHATRONICS 2004 : proceedings of the 7th international symposium.* Bratislava : Slovak University of Technology, Faculty of Mechanical Engineering, 2004. ISBN 80-227-2064-X.

[3] FROLLO, Ivan (editor) - TYŠLER, Milan (editor) - JURAŠ, Vladimír (editor). *MEASUREMENT 2005 : 5th international conference on measurement.* Bratislava, Slovakia : Institute of Measurement Science, SAS, 2005. 578 s. ISBN 80-967402-8-8.

[4] HAIN, Miroslav (editor). *Workshop COST G8 : in-situ non-destructive analysis and testing of museum objects*. Bratislava : Institute of Measurement Science, SAS, 2005. ISBN 80-967402-9-6.

[5] WITKOVSKÝ, Viktor (editor). *PROBASTAT 2006 : the fifth international conference on probability and mathematical statistics. Abstracts.* Bratislava, Slovakia : Institute of Measurement Science, SAS, 2006.

- **National position of the Organisation**

i. List of selected most important national projects (Centres of Excellence, National Reference Laboratories, Agency for the Promotion of Research and Development (APVV/APVT), National Research Programmes, Scientific Grant Agency of the Slovak Academy of Sciences and the Ministry of Education (VEGA), and others)

[1] Centre for Non-Standard Measurements (at the IMS SAS): http://www.um.sav.sk/en/centre-of-non-standard-measurements.html

[2] Centre for NMR material imaging (as part of National NMR centre)

[3] 6 APVV projects and 1 National Research Programme (given in detail in part "National projects and funding")

[4] VEGA project No. 2/1133/22 (Development of non-contact optical methods for measurement of position and geometrical functional parameters of 3D objects)

[5] VEGA project No. 2/3180/23 (Infrared thermometry, thermography and reflectography – development of selected methods and tools)

[6] VEGA project No. 2/1134/23 (The high-temperature superconducting composites and contacless measuring methods and systems based on SQUID sensors)

[7] VEGA project No. 2/1136/23 (The utilization of self-organizing neural networks and nonlinear dynamics methods in signal analysis)

[8] VEGA project No. 2/2040/22 (Low Field Imaging Methods Based on Nuclear Magnetic Resonance)

[9] VEGA project No. 2/1135/22 (Multilead measurement and analysis of low-level bioelectric signals)

[10] VEGA project No. 2/4091/04 (High-temperature superconductors, their magnetic properties and development of SQUID magnetometric methods)

[11] VEGA project No. 2/4026/24 (Analysis of EEG based on advanced methods of mathematicalstatistics, artificial neural networks and nonlinear dynamics).

[12] VEGA project No. 2/4089/24 (Assessment of Heart Repolarization Changes by Multilead ECG Measurements)

[13] VEGA project No. 2/5043/25 (Specific Imaging Methods Based on Magnetic Resonance)

[14] VEGA project No. 1/0264/03 (New nonlinear methods of mathematical statistics)

[15] VEGA project No. 1/3016/26 (New nonlinear methods of mathematical statistics II)

ii. List of national scientific conferences (co)-organised by the Organisation

0

iii. List of national journals published by the Organisation

0

iv. List of edited proceedings of national scientific conferences/events

0

- **International/European position of the individual researchers**

i. List of invited/keynote presentations at international conferences, documented by an invitation letter or programme

[1] TYŠLER, M. – TURZOVÁ, M. – TIŇOVÁ, M. – SZATHMÁRY, V. – FILIPOVÁ, S.: Possible use of high resolution BSPM data for model-based methods for heart state assessment. In: Seminar on HR ECG / MCG mapping. International Centre of Biocybernetics, IBIB PAN, Warszawa, Poland, October 16-19, 2003.

[2] KNEPPO, P. – TYŠLER, Milan: Modeling of the cardiac electric field. In: Scientific Conference to 10th Anniversary of Biomedical Engineering Centre. Tallinn, Estonia, October 14, 2004.

[3] FROLLO, I.: Role of the radio-electronics in magnetic resonance imaging development. In: Radioelektronika 2004. 14th International Czech-Slovak Scientific Conference. Bratislava, Slovak Republic, April 27-28, 2004.

[4] TYŠLER, M.: Localization of acute ischemic lesions from QRST integral maps. In: ELECTROCARDIOLOGY 2005. The 11th Congress of the ISHNE and the 32nd Congress of the ISE. Gdansk, Poland, June 2-4, 2005.

[5] WITKOVSKÝ, V.: Analýza rozptylu a zmiešaný lineárny model. In: ROBUST 2006. 14. zimní škola JČMF. Lhota nad Rohanovem, ČR, 23.-27. ledna 2006.

[6] GRENDÁR, M.: Boltzmann Jaynes Inverse Problem: Maximum Probability and Maximum Entropy. Workshop on Maximum Entropy analysis, Canberra, 28-29 september 2006.

[7] TYŠLER M. – ŠVEHLÍKOVÁ J. – TURZOVÁ M. – HEBLÁKOVÁ E.: Použitie modelov na interpretáciu meraných srdcových potenciálov (Use of models for interpretation of measured cardiac potentials) XXIXth Days of Medical Biophysics): ExpoClub Incheba, Bratislava, May 16-18, 2006.

ii. List of employees who served as members of the organising and/or programme committees for international conferences

[1] I.Frollo – 13 activities

[2] M. Tyšler – 8 activities

[3] V. Witkovský – 7 activities

[4] J. Bartl - 5 activities

[5] M. Hain – 5 activities

[6] K. Karovič – 4 activities

[7] J. Maňka - 3 activities

[8] P. Andris - 3 activities

Detailed lists are given in the annual reports (accessible on the Institute website).

iii. List of employees who served as members of important international scientific bodies (e.g. boards, committees, editorial boards of scientific journals)

[1] J. Bartl:
Member of the Committee of the CS section of The International Society for Optical Engineering SPIE.
Member of the Coordination board of the International Laser Centre
Member of the editorial board of the journal: Fine mechanics and optics, AV ČR Praha.

[2] K. Karovič:
Member of the DAAD commission for joint Slovak-German projects.
Member of the editorial board of the journal: Fine mechanics and optics, AV ČR Praha.

[3] M. Hain:
Member of the steering committee of the action COST G8.

[4] V. Zrubec:
Member of the IMEKO TC-4 committee

[5] I. Frollo:
Member of the IMEKO TC-7 committee
Vice-president of the URSI subcommittee
Member of the International Committee on Measurements and Instrumentation (ICMI)

[6] M. Tyšler:
Member of the committee: International Council of Electrocardiology
Member of the IMEKO TC-13 committee

iv. List of international scientific awards and distinctions

[1] Patent No. 89363 with the title: “Precession X-ray diffraction camera”, authors F. Hanic, J. Maďar, V. Kiss and given camera became since 2002 the permanent exhibit in the National museum in Prague and since 2004 in the Technical museum in Košice.

- **National position of the individual researchers**

i. List of invited/keynote presentations at national conferences documented by an invitation letter or programme

[1] BARTL, J.: Speckle interferometria (Speckle interfetometry). In: Jednota slovenských fyzikov. Trnava, Katedra fyziky MTF STU, 26.4.2004.

ii. List of employees who served as members of organising and programme committees of national conferences

[1] J. Bartl - 3 activities

Detailed lists are given in the annual reports (accessible on the Institute website).

iii. List of employees serving in important national scientific bodies (e.g. boards, committees, editorial boards of scientific journals)

[1] K. Karovič:

Scientific board of the Faculty of Electrical Engineering and Information Technology, STU Bratislava

Slovak National Acreditation Servise – chairman of the Slovak Acreditation Board

Member of the scietific board of the Slovak Institute of Metrology

Member of the board: Action Austria-Slovakia

[2] J. Bartl:

Editor of the journal: Metrological letters

Editor of the journal: Metrology and Testing

Slovak Optical Committee

Member of the board of the National Program of Quality

Slovak National Acreditation Servise

Member of the board of the International Laser Centre

[3] I. Frollo:

Member of the editorial board: Journal of Electrical Engineering

Member of the scietific board of the Slovak Institute of Metrology

Editor in Chief of the journal: Measurement Science Review

[4] J. Volaufová:

Member of the editorial board oj the journal: Acta Mathematica Universtatis Comenianae

Member of the editorial board oj the journal: Tatra Mountains Mathematical Publications

[5] V. Witkovský:

Executive editor of the journal: Measurement Science Review

Member of the Commission for Biometrics of the Slovak Academy of Agricultural Sciences

[6] M. Tyšler:

Member of the editorial board of the journal: Measurement Science Review

Scientific secretary of the Society for Biomedical Engineering and Medical Informatics

iv. List of national awards and distinctions

[1] J. Bartl: Silver medal ZSVTS for active work in Slovak Metrological Society

[2] K.Karovič:

Medal of the SAS for the support of science

J.A. Segner prize for metrology

[3] V. Zrubec: Award of the Presidium of the SAS – emitent jubilee personality

[4] I. Frollo:

Medal for Science Contribution, award of the Slovak Academy of Sciences

Silver medal and Memorandum from Faculty of Electrical Engineering, Žilina University

Gold medal of Johann Andrea von Segner from Slovak Office of Standards, Metrology and Testing. 85 Anniversary of Metrology in Slovakia

Big medal of Saint Gorazd in the Day of Teachers given by Ministry of Education SR

Memorandum from Slovak Office of Standards, Metrology and Testing, 130 Anniversary of Metric Convention and 50 Anniversary of International Organisation for Legal Metrology foundation

[5] I. Farkaš: "Prize of Peter Fedor for support and distinction of young scientists" awarded by the rector of the Slovak Technical University in Bratislava.

Supplementary information and/or comments documenting international and national status of the Organisation

Research team of the Department of Optoelectronic Measuring Methods has been awarded by outstanding national award, the "Slovak Gold" for the Optoelectronic systems for tilt measurement of nuclear power stations that was implemented in Jaslovske Bohunice and Mochovce nuclear power stations.

In comparison with previous assessment period, both national and international position of the Institute strengthened what is reflected in increasing number of funded projects, more multilateral international projects, and particularly, we joined 2 new FP6 projects. Intensity of contacts with international scientific and professional societies remained high. There were more invited lectures and both, the international conference Measurement and the journal Measurement Science Revue gained attention of the international scientific and professional community that is reflected in larger numbers of interested participants, journal contributors and citations. On national level, there exists lasting scientific and pedagogic cooperation with several Universities, partners from industry, cultural and healthcare institutions. The number of common laboratories has increased, one of them is newly established Centre for Non-standard Measurements.

4. Project structure, research grants and other funding resources

- **International projects and funding**

i. List of major projects within the European Research Area – 5th and 6th Framework Programme of the EU, European Science Foundation, NATO, COST, INTAS, CERN, etc. (here and in items below please specify: type of project, title, grant number, duration, funding, responsible person in the Organisation and his/her status in the project, e.g. coordinator, principal investigator, investigator)

[1] Type: 6th FP, "Integrating and strengthening the European Research Area"
Title: Breath-gas analysis for molecular-oriented detection of minimal diseases (BAMOD)
Grant: LSHC-CT-2005-019031 STREP
Duration: 2/2006 – 1/2009
Funding: 1 121 000 SKK
Responsible: ass. prof. RNDr. Viktor Witkovský, PhD., principal investigator
Coordination: prof. Anton Amann, Medical University Innsbruck, Austria (13 partners from 5 countries)

[2] Type: 6th FP, "Maria Currie"
Title: Polarized Helium Lung Imaging Network (PHELINET)
Grant: MRTN-CT-2006-036002
Duration: 12/2006 – 12/2010
Funding: 153 695 EUR
Responsible: prof. Ivan Frollo,
Coordination: Université Claude Bernard Lyon 1, France (16 partners)

[3] Type: COST
Title: Non-destructive analysis and testing of museum objects
Grant: COST G8
Duration: 1/2002 –2/2006
Funding: 278 885 SKK, (during assessed period)
Responsible: RNDr. Miroslav Hain, investigator, member of the management committee
Coordination: Prof. Annemie Adriaens, Ghent University. Belgium (partners from 20 countries)

[4] Type: Eureka
Title: Low-field magnetic resonance imaging (MRI) for medical applications
Grant: E! 2012 LOW-FIELD NMR
Duration: 02/2001 – 01/2007
Responsible: prof. Ivan Frollo, principal investigator
Coordination: Universitaet Wien, Surgery Department, Wien, Austria (5 partners)

[5] Type: Leonardo da Vinci
Title: METROMEDIA – ONLINE
Duration: 01/2005 – 121/2005
Responsible: prof. Ivan Frollo, principal investigator
Coordination: M. Halaj, PhD., Faculty of Mechanical Engineering STU Bratislava

ii. List of other international projects incl. funding

[1] Type: Cooperation in Science & Technology
Title: Carcinoma screening based on exhaled breath
Grant: SK-AT 00206
Duration: 7/2006 – 12/2007
Funding: 60 000 SKK (2006)
Responsible: ass. prof. RNDr. Viktor Witkovský, PhD., coordinator
Partner: prof. Anton Amman, Medical University of Innsbruck, Austria

[2] Type: Cooperation in Science & Technology
Title: Apparatus for magnetic field cycle control of Nuclotron accelerator
Grant: N 08626319/041653-74
Duration: 1/2005 – 6/2008
Funding: 273 504 SKK (2005), 160 000 SKK (2006)
Responsible: Ing. Ľubomír Ondriš, PhD.
Partner: JINR Dubna, Russia

[3] Type: Cooperation in Science & Technology
Title: Research into refined classification of bands in EPO images (GASepo)
Grant: PO-5410027060
Duration: 1/2005 – 6/2005
Funding: 9 200 EUR
Responsible: ass. prof. RNDr. Viktor Witkovský, PhD.
Partner: ARC Seibersdorf research, GmbH, Austria

[4] Type: Preparatory activities for FP6
Title: Specific Targeted Research Project BAMOD
Grant: SAIA 51s 02
Duration: .8/2005 – 12/2005
Funding: 1 856 EUR, 37 786 SKK
Responsible: ass. prof. RNDr. Viktor Witkovský, PhD.
Partner: Medical University of Innsbruck, Austria, Mathematical Institute SAS

[5] Type: Bilateral Cooperation in Science & Technology
Title: Research and education in the field of biomedical engineering
Grant: contract for project MŠMT ČR, MSM 6840770012
Duration: 6/2005 – 12/2006
Funding: 127 000 SKK (2005), 284 000 SKK (2006)
Responsible: Ing. Milan Tyšler, PhD.
Partner: Czech Technical University in Prague, Faculty of Biomedical Engineering, Kladno, Czech Republic

iii. List of other important projects and collaborations without direct funding

[1] Type: Billateral Cooperation in Science & Technology
Title: Research and Applications on HTc-superconductor
Duration: 1/1999 – (not limited)
Responsible: Ing. Ján Maňka, PhD.
Partner: Research Group on Solid State Chemistry and Ceramic Superconductors, Department of Inorganic and Physical Chemistry WE06V, University of Ghent

[2] Type: Bilateral Cooperation in Science & Technology
Title: Development of the accelerator facility NUCLOTRON
Grant: 3302-1-0-01/01
Duration: 1/2001 - 12/2004
Responsible: Ing. Ľubomír Ondriš, PhD.
Partner: JINR Dubna, Russia

[3] Type: Bilateral Cooperation in Science & Technology
Title: Noninvasive Measurement and Information Analysis of Bioelectric Signals
Duration: 10/2001- (not limited)
Responsible: Ing. Milan Tyšler, PhD.
Partner: Institute for Problems of Information Transmission, RAS, Moscow, Russia

[4] Type: Trilateral Cooperation in Science & Technology
Title: Research of the cardiac electric field
Duration: 1/2004 – 12/2006
Responsible: Ing. Milan Tyšler, PhD.
Partners: CRIP Research Institute for Material Science and Technical Physics, Hungarian Academy of Sciences, Budapest, Hungary, Institute of Normal and Pathological Physiology SAS, Bratislava

[5] Type: Billateral Cooperation in Science & Technology
Title: Analysis and Modelling of Cardiac Electric Field based on HR ECG Body Surface Mapping
Duration: 1/2004 – 12/2006
Responsible: Ing. Milan Tyšler, PhD.
Partner: Institute of Biocybernetics and Biomedical Engineering, PAS, Warszawa, Poland

[6] Type: Billateral Cooperation in Science & Technology
Title: Modern methods for evaluation of electrophysiological signals
Duration: 7/2006 – 12/2008
Responsible: ass. prof. RNDr. Viktor Witkovský, PhD., project coordinator
Partner: Institute of Informatics, AS of the Czech Republic

- **National projects and funding**

i. List of projects supported by the Agency for the Promotion of Research and Development (APVV/APVT), National Research Programmes, and their funding

[1] [1]

Type of the project:	APVT
Title:	New methods and devices for pulmonary, hepatic and gastro-intestinal non-invasive diagnostics
Grant number:	APVT- 51- 017802
Duration:	09/2002 – 07/2005
Responsible person:	Ing. Milan Tyšler, CSc.
Status in the project:	Principal investigator
Funding:	1 625 000,- SKK (2003)
	1 309 000,- SKK (2004)
	1 023 000,- SKK (2005)

[2]

Type of the project:	APVT
Title:	Research of the stabilisation of the diode lasers optical frequencies
Grant number:	APVT- 51-012102
Duration:	09/2002 - 08/2005
Responsible person:	RNDr. Ing. Ján Bartl, CSc.
Status in the project:	Principal investigator
Funding:	2 107 000,- SKK (2003 – 2005)

[3]

Type of the project:	APVT
Title:	Investigation of high temperature thin film detectors for superconducting quantum interference devices - SQUID
Grant number:	APVT-51-022702
Duration:	09/2002 – 08/2005
Principal investigator:	RNDr. Štefan Beňačka, CSc. (Electrotechnical Institute SAS, Bratislava)
Responsible person:	RNDr. Alexander Cigáň, CSc.
Status in the project:	Partner
Funding:	280 000,- SKK (2004, only)

[4]

Type of the project:	APVT
Title:	Advanced coal materials on the base of Slovak raw materials for sustainable development
Grant number:	APVT-51-036102
Duration:	01/2004 – 12/2006
Principal investigator:	Doc. Ing. Ľudmila Turčaniová, CSc., (Institute of Geotechnics SAS, Bratislava)
Responsible person:	Doc. Dr. Ing. František Hanic, DrSc.
Status in the project:	Partner
Funding:	277 000,- SKK (2004, only)

[5]

Type of the project:	APVT
Title:	Application of magnetic and electric measuring methods in non-invasive examination of liver and heart
Grant number:	APVV-99-P06305
Duration:	09/2005 - 08/2007
Principal investigator:	Prof. Ing. Mudroň Ján CSc., (MAGIC TRADING CORPORATION, a.s. Liptovský Mikuláš)
Responsible person:	Prof. Ing. Ivan Frollo, DrSc.
Status in the project:	Partner
Funding:	917 000,- SKK (2006)

[6]

Type of the project:	APVT
Title:	Application of magnetic and electric measuring methods in non-invasive examination of liver and heart
Grant number:	APVV- 51-059005
Duration:	05/2006 - 12/2008
Responsible person:	Ing. Ján Maňka, CSc.
Status in the project:	Principal investigator
Funding:	1 514 000,- SKK (2006)

[7]

Type of the project:	National Research Programme
Title:	Completing of the top-ranking laboratory with orientation to nuclear magnetic resonance
Grant number:	ŠP 06K0A02
Duration:	12/2006 - 12/2010
Principal investigator:	Doc. Ing. Tibor Liptaj, CSc. (Slovak Technical University Bratislava)
Responsible person:	Prof. Ing. Ivan Frollo, DrSc.
Status in the project:	Partner
Funding:	(since 2007)

ii. Number of projects supported by the Scientific Grant Agency of the Slovak Academy of Sciences and the Ministry of Education (VEGA) for each year, and their funding

VEGA	2003	2004	2005	2006
number	8	6	8	6
funding (millions of SKK)	0,955	0,922	1,064	1,395

- **Summary of funding from external resources**

External resources	2003	2004	2005	2006	total	average
external resources (millions of SKK)	9,439	7,302	8,567	8,854	34,162	8,541
external resources transfered to coooperating research organisations (millions of SKK)	0,000	0,000	0,113	0,246	0,359	0,090
ratio between external resources and total salary budget	0,631	0,480	0,188	0,565	-	0,466
overall expenditures from external as well as institutional resources(millions of SKK)	31,440	29,264	30,332	31,949	122,985	30,746

Supplementary information and/or comments on research projects and funding resources

Overall number of funded projects increased significantly within past 4 years (from 12 in 2002 to19 in 2006) and their structure has significantly and positively changed. While the number of VEGA projects decreased from 7 to 6 (2 cooperative projects), number of other project types with better financial support, both national (APVV, APVT, ESF) and international (FP6, COST, Eureka, bilateral) increased (from 3 national and 2 international in 2002 to 6 national and 7 international in 2006) and also the funding was improved (from 2.2 to 8.8 mil. Sk, despite some inconsistency in the methodology exists). The very positive result of the assessed period is that 2 European projects, 1 COST and 1 Eureka project were supported. Moreover, we got support for 1 National Science and Technology Support project and for 2 projects from the European Social Fund.

5. Organisation of PhD studies, other pedagogical activities

i. List of accredited programmes of doctoral studies (as stipulated in the previously effective legislation as well as in the recently amended Act on the Universities)

Doctoral studies accredited according previously effective legislation (running until 2010):

39-52-9 Bionika a biomechanika (Bionics and biomechanics)
common departmental commission with Technical University in Košice, Faculty of Mechanical Engineering

39-71-9 Meracia technika (Measurement Technology)
common departmental commission with Slovak Technical University in Bratislava, Faculty of Electrical Engineering and Information Technology

Doctoral study accredited in accordance with the recent Act on the Universities:

5.2.54 Meracia technika (Measurement Technology) – accredited since March 29, 2006 as external educational institution of the Slovak Technical University in Bratislava, Faculty of Electrical Engineering and Information Technology for both, internal and external study program.

ii. Summary table on doctoral studies (number of internal/external PhD students; number of students who completed their study by a successful thesis defence; number of PhD students who quitted the programme)

PhD study	31.12.2003			31.12.2004			31.12.2005			31.12.2006		
number of potential PhD supervisors	14			14			14			14		
PhD students	number	defended thesis	students quitted	number	defended thesis	students quitted	number	defended thesis	students quitted	number	defended thesis	students quitted
internal	7		5	6	1	2	11	1	2	8	1	2
external	3			5		1	5			4	1	2
supervised at external institution by the research employees of the assessed organisation	3			2			5			3		

iii. Postdoctoral positions supported by

a) external funding (specify the source)

no

b) internal funding - the Slovak Academy of Sciences Supporting Fund of Stefan Schwarz

no

iv. Summary table on pedagogical activities in undergraduate programmes for each year

Teaching	2003	2004	2005	2006
lectures (hours/year)	328	449	302	385
practicum courses (hours/year)	145	124	63	60
supervised diploma works (in total)	6	10	12	5
members in PhD committees (in total)	9	8	9	8
members in DrSc. committees (in total)	3	3	3	2
members in university/faculty councils (in total)	1	1	1	1
members in habilitation/inauguration committees (in total)	1	2	3	2

v. List of published university textbooks

[1] FROLLO, Ivan - HALAJ, M. Measurement of frequency of rotation. In *Meaurement in Technology : a textbook from the multimedia courseware Metromedia-Online*. Volume II. Vienna, Austria, 2005. ISBN 80-89112-05-6. P. 445-466.

[2] FROLLO, Ivan - HALAJ, M. Meranie frekvencie otáčania. In Technické meranie. Zväzok II., Viedeň, Rakúsko, 2005. ISBN 80-89112-04-8. S. 436-454. (Slovak version of [1]).

vi. Number of published academic course books

0

vii. List of joint research laboratories/facilities with the universities

[1] Academy of Fine Arts and Design, Department of Restoration – Laboratory for physical examination of artworks.

[2] Faculty of Mechanical Engineering STU and Faculty of Electrical Engineering and Information Technology STU in the framework of Centre of Non-Standard Measurements (with residence at the Institute of Measurement Sciece).

[3] Faculty of Civil Engineering STU, Department of Surveying.

viii. Supplementary information and/or comments on doctoral studies and pedagogical activities

There was significant effort in the past 4 years to increase the number of PhD students as an important scientific potential of the Institute. As the SAS rules did not allow to admit more than 1 or 2 students per year we submitted a project asking for support from the European Social Fund that enabled us to admit and finance 5 more PhD students since 2005. The number of finished PhD students during the assessed 4-year periods increased from 1 to 4.
Exceptional attention was also paid to accreditation of the new PhD study program “Measurement Technology” in accordance with the new Act of the Universities. The program was accredited in March 2006.

Number of pedagogically active employees grew (from 15 to 19 per year in average), number of lectures increased by 40% while number of courses decreased by 35%. Due to the new legislative, the number of supervised bachelor and diploma works dropped to 10%.

6. Direct output to the society (applications of results, popularisation and outreach activities)

i. List of the most important results of applied research projects

[1] Optoelectronic systems for tilt measurement of nuclear reactors in power stations
Systems for nuclear reactor tilt monitoring were developed and installed in nuclear power stations in Slovak Republic and are being routinely used for several years.
This measuring system obtained the “Slovak Gold” award in 2004.
Applicator: Slovenske elektrarne company.

[2] Laser measurement of geometric parameters of electric motor commutators.
Optoelectronic measuring system for fast contactless measurement of width and angle position of segments and isolation gaps of commutators was designed and developed.
Applicator: KOMUTEX, Czech republic.

[3] Magnetopneumographic system for lung diagnostics
Device and method for non-invasive magnetometric method using SQUID sensors and superconducting gradiometers for determination of the long-term contamination level of the human lungs with ferromagnetic dust was developed.
Applicators: Clinic of the Occupational Medicine and Toxicology, Faculty of Medicine, Comenius University

[4] Automated system for experiments with stress loadings by hypergravitation
Equipment for experiments on small animals that are subjected by hypokinesis or hypergravitation equipped by telemetric control system and programmable blood collection was developed
Applicator: Institute of Experimental Endocrinology SAS
Institute of Biochemistry and Genetics of Animals SAS

[5] Active electrodes for multichannel biosignal measurement
New construction of active electrode was developed. It is built on SMD technology and contains thermally compensated amplifier, high input and very low output impedance. It has original electromechanical solution consisting of miniature active adapter with snap and quality single-use commercial electrode.
Applicator: CTU in Prague, Faculty of biomedical Engineering, Kladno

[6] ProCardio 7 - device for measurement and analysis of the cardiac electric field.
System for multichannel ECG measurement and topographical representation of the cardiac electric field on the body surface that can be used for diagnostics of cardiac diseases was developed.
Applicator: National Institute of Cardiovascular Diseases.

[7] Non-destructive optical method for works of art testing.
Optical methods based on infrared reflectography and ultraviolet fluorescence were developed and are used for revealing of underdrawings in pictures.
Applicator: Chamber of Restorers, Academy of Fine Arts and Design
National Institute for Monuments Protection, Slovakia

[8] Image processing algorithms for Erythropoietin (Epo) doping substance detection.
Easy to use software system aimed at the standardized quantitative analysis of digital images acquired during the process of erythropoietin (Epo) doping control was developed significantly reduces local geometric distortions in Epo images.
Applicator: ARC Seibersdorf Research GmbH, Austria

[9] Osteoporosis diagnostics using magnetic resonance imaging methods.
Technical aspects related to the observation of the bone osteoporotic status using the methods of MR imaging were studied. This enables practical use of the method.
Applicator: Universitá degli Studi di Trieste, Trieste, Italy

ii. List of the most important studies commissioned for the decision-making authorities, the government and NGOs, international and foreign organisations

[1] BARTL, J. Comments on Organization Exceptionality Pricing Program according to EFQM model and for National Quality Price of SR. (Material for National Quality Programme of SR Council), 27th May 2006.

[2] BARTL, J.: Accreditation in research. /Attitude to accreditation of research organization for National Quality Program of SR Council) 22nd August 2006

[3] FROLLO, I.: Evaluation reports of two projects within the National Research Programmes (2003SP2002802002 and 2003SP200280203).

[4] KAROVIČ, K.: Evaluation report of the project “Convergence of ITC networks and services in the communication infrastructure of the Slovak Republic” within the National Research Programmes.

[5] TYŠLER, M.: Evaluation report of the project “New materials and devices for sub-micrometer technology” within the State Order Programme.

iii. List of the most important popularisation activities

[1] Regular presentations and lectures presenting the research results and its applications for public during the “Open Days at the Institute of Measurement Science”. The action is organized regularly each year within the “European Science Week” and “Science Week Slovakia” organized by Slovak Ministry of Education and the Slovak Academy of Sciences, 2004-2006..

[2] Excursions for university students presenting research activities and laboratories of the Institute, organized with co-operation with Žilina University in Žilina, 2003-2006.

[3] Presentation of research results and its applications through at the exposition „A Miraculous Science Year“ organized together with Slovak National Museum to the public. In 2005 the Institute presented two exhibitions: “Infrared radiometry, reflectography and UV Fluorecececy” and “Photoelecrtric phenomenon”.

[4] Interview by M. Tyšler and M. Teplan in Slovak TV within the broadcast of “Reporters”, 13. Feb. 2006.

iv. List of patents issued abroad, incl. revenues

0

v. List of the patents issued in Slovakia, incl. revenues

0

vi. List of licence sold abroad, incl. revenues

0

vii. List of licences sold in Slovakia, incl. revenues

0

viii. List of contracts with industrial partners, incl. revenues

[1] Systems for nuclear reactor tilt monitoring. Co-operation with Nuclear Power Station Mochovce and Jaslovske Bohunice (1 400 000,- Sk)

ix. List of research projects with industrial partners, incl. revenues

[1] Laser measuring system for the fast measurement of functional geometric parameters of electric motor commutator. Co-operation with the company Mesing, Czech rep. (200 000,-. Sk)

[2] Research of the optical measuring methods and procedures for the fast control of surfaces in the precision engineering. Co-operation with the company Mesing, Czech rep. (250 000,-. Sk)

[3] Non-destructive testing of works of art. Co-operation with the National Institute for Monuments Protection (97 000,- Sk)

[4] BioLab EPP – sensor of cardiovascular biosignals. AXISplus SK (40 500,- Sk)

[5] BioLab ATR – sensor of Achilles tendon reflex signals. Association of service engineers of industrial and commercial electronics (28 300,Sk)

x. Summary of outreach activities

Outreach activities	2003	2004	2005	2006	total
studies for the decision sphere, government and NGOs, international and foreign organisations	12	4	4	5	25
articles in press media/internet popularising results of science, in particular those achieved by the Organization	5	3	0	4	12
appearances in telecommunication media popularising results of science, in particular those achieved by the Organization	0	0	0	1	1
public popularisation lectures	1	6	10	5	22

xi. Supplementary information and/or comments on applications and popularisation activities

Particularity of the Institute is its relatively strong orientation to biomedical research. Numerous results of the research are applicable in clinical conditions. Because of the strict regulations in this field, in most cases they can be used merely as experimental devices and/or methods. Despite the economical effect of such applications is many times very limited we consider them as important part of our activities enabling in some cases plumbless improvement of quality of life of the patients.
Because of the problem to recruit the skilled young collaborators, more our popularization activities in recent years (open days, university excursions) were focused on students of selected specializations with the aim to attract them as possible future PhD students.

7. Background and management. Staffing policy and implementation of findings from previous assessments

i. Summary table of personnel

Personnel	2003	2004	2005	2006
all personel	76	76	73	70
research employees from Tab. Research staff	39	44	41	47
FTE from Tab. Research staff	32	35,2	33,9	35,6
averaged age of research employees with university degree	50	48	50	50

ii. Professional qualification structure

Number of	2003	2004	2005	2006
DrSc.	4	4	4	4
PhD / CSc.	25	25	25	22
Prof.	1	1	1	1
Doc./Assoc. Prof.	3	3	5	6

iii. Status and development of research infrastructure incl. experimental, computing and technical base (description of the present infrastructure, premises, and material and technical resources. Infrastructure, instrumentation and major technical equipment necessary for the achievement of the objectives specified in the research Concept)

The development of the Institute's infrastructure strongly depends on financial possibilities. Due to changed legislative in the previous period, our Institute as institution getting contribution from the state budget was forced to housekeeping with real depreciations of assets. Because no capital funds could be accumulated in the previous period or obtained from the SAS, little space was left for capital investments. In years 2003-2005 practically only small devices, PC computers or software could be bought from running expenses. Gradual accumulation of funds from obtained grants enabled to invest 1.5 mil. SKK in 2006, mostly to innovation of computer and communication network and institute's new data and information server. Budgetary suppositions may enable another increase of investments in 2007 (up to 3 mil. SKK for devices and up to 4 mil. SKK for unavoidable investments into the Institute's building).
We hope to be able significantly to improve the Institute's infrastructure with the help of projects within European Structural Funds expected in 2007-2011.
Despite these facts, the Institute has all the necessary basic infrastructure for running research projects: excellent information network, sufficient PC equipment and number of valuable devices, technologies and special laboratories, partially of own development and construction. Most important of them are:

- Detached laboratory for measurement of extremely weak magnetic fields (home made SQUID gradiometric system with equivalent sensitivity of ~20×10^{-15} T $Hz^{-1/2}$ in the white noise range, cryogenic equipment) – it includes a biomagnetic laboratory.

- Laboratory of Magnetic Resonance Imaging (MRI). The laboratory is equipped with the whole-body experimental scanner TMR 96, 0.1 Tesla, 6-coil resistive water cooled magnet, high stability and field homogeneity of the basic magnetic field. 14 – coil system for magnetic field correction, control console: S.M.I.S., gradient amplifiers: Tegmag, RF transmitter: 2 kW, operational frequency 4.45 MHz, RF coils for whole body and head imaging and special small dimensional high sensitive coils for imaging with high resolution.
- Laboratory of synthesis of high-temperature superconducting materials.
- Optical laboratory: optical-fibre spectrometer, low power HeNe and diode lasers, optical power meters, choppers, lock-in amplifiers, CCD cameras, digital oscilloscope, laboratory optical tables, set of refractive and reflective optical elements and filters, wave retardation plates, optical insulators. The laboratory is also equipped with: external cavity diode laser 633 nm, which can be used for high resolution spectroscopy and stabilisation of optical frequency in the order 10^{-11}, and thermographic camera
- Partially shielded laboratory for biomedical experiments equipped with specialized devices developed also within research and technology projects (BioLab ATR, BioLab STI and EEG).

Another technologies and devices are available within existing national and international cooperations, e.g. XRD, TGA and DTA.

iv. Status and development of bibliographic resources, activities of the Organisation's library and/or information centre

The library contributes to the central account of the publication activity of the Slovak Academy of Sciences (EPCA) – 1342 records and to the electronic catalogue of books (ARL) – 2000 records. These are accessible on the web.

Number of books and journals:

	2003	2004	2005	2006
Books	13 513	13 532	13 538	13 557
Journals	28	27	22	18

The number of subscribed periodicals decrease as the research workers have an access to increasing number of on-line full-text databases.

Provided services:

- bibliografic information
- literature search from the electronic databases
- lending journals, books
- reprography services

Other activities:

- account of the publication activity and citations

v. Describe how the results and suggestions of the previous assessment were taken into account

Conclusions of the previous accreditation suggested:
1. to pay attention to doctoral study,
2. to increase participation in European projects, namely EU 6FP,
3. to pay attention to National Science and Technology support programs and Governmental orders,
4. to participate in Technological parks,
5. to try to improve patenting.

Results:
1. 1.During the assessed period exceptional attention was paid to the doctoral study. As stated in corresponding part of this document, new doctoral program was successfully accredited. Besides the quota from SAS, 5 additional PhD students were admitted within an ESF project. The number of defended PhD students increased from 1 to 4.
2. Our participation in European projects was discussed earlier, in contrast to previous period we were much more successful and got support within 2 EU FP6 projects, 1 COST and 1 Eureka project.
3. The participation in National S&T Support Programs and Governmental Orders strongly depends on the existing calls (and their availability may change depending on economical and political circumstances). Despite these facts we succeeded to obtain support within one National S&T Support Program project for building of excellent NMR lab within National Center for NMR material imaging.
4. The actual real development of Technological parks in Slovakia did not allow to obey this recommendation.
5. Appropriate attention was paid to patenting and number of patent applications increased from 1 to 5, number of granted patents increased from 0 to 2.

vi. Supplementary information and/or comments on management, research infrastructure, and trends in personnel development

Together with limited financial possibilities, for faster building of infrastructure competitive in European research area, we consider personal development as the limiting factor for the future success of the Institute. In the open labour market, namely technical Institutes of the Slovak Academy of Sciences missed some of their former advantages and we had to face the walk-off of many excellent coworkers to developed countries. This fact created a generational gap in our personnel some 15 years ago that influences also our current scientific capacity. Also today, financial and legislative limitations embarrass the chance to attract best students for PhD study.
Possibility to apply for support from European structural funds gives us the chance of stepwise improvement of the research infrastructure and their acquisition is our top priority in the coming years. Similarly, orientation to themes of the EU 7th FP and acquiring of additional EU projects can improve conditions for our young scientists and is therefore our nearest goal.