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# IN
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## DEVELOPMENT OF THE RESEARCH INFRASTRUCTURE

*Guiding political documents of the European Union focusing on formation of knowledge economy highlight as the main goal the necessity of development of a new research infrastructure in the priority research areas.*

*The EU clearly proclaims its ambitions to create modern infrastructural complexes on the world level in particular key spheres, which will be accessible for researchers from different countries.*

*Acceptance of the so-called European Roadmap including 35 large-scale research infrastructures is an important measure directed to improvement of the research infrastructure condition. They ought to be developed during the forthcoming years (the term for creation of separate infrastructures is between 5 and 10 years), so that to guarantee conditions for high-quality and competitive research investigations. Every year Member States can update the Roadmap by suggesting new projects.*

*The problem with absence of a modern infrastructure for realization of research investigations is more serious in Bulgaria. During recent years the state supported renovation of the research infrastructure both through financing of institutions and through the instruments of project financing. In 2008 the Research Investigations Fund supported 29 infrastructural projects.*

*The goal of the competition was:*

- *to encourage inter-institutional integration of universities and higher educational institutions, research units of the Bulgarian Academy of Sciences and Agricultural Academy, enterprises, non-profit organizations, etc.;*
- *to intensify the link between science and business;*
- *to create and develop a specialized research infrastructure for collaborative use by a union of at least three research organizations, guarantying implementation of quality and competitive research investigations, educative and diagnostic activities in several priority spheres: renewable energy sources and energy-saving technologies; biotechnologies, food and health; material science and nanotechnologies; information and communication technologies; ecology, climate changes, biodiversity and biological resources; cultural-historical heritage, national identity and social environment; research investigations in support of strong and working Bulgarian industry.*

*National research strategy envisages assistance from the state in providing of a modern infrastructure and research equipment in the leading units developing the priority research fields. Leading research units will be specified on the basis of an independent international evaluation. Basic requirement will be that the equipment and infrastructure provided to these units by budgetary funds must be accessible for research teams, research institutions, units with research activities at enterprises, including to practical training of students and doctoral students. The state guarantees equal access for all universities and research organizations to electronic databases, which are an essential element of the research innovative policy. Bulgaria takes part in the preparative phase of five European infrastructural projects – development of electronic linguistic models; formation of a European sociological investigation; building up of a global system for monitoring of the oceans; construction of a ship for polar and sea research; creation of a European installation for obtaining of very rare radioactive isotope rays; development of a light laser working on ultra short impulses for splitting protons into electron-positron pairs.*

# NACID

## National Centre for Information and Documentation

**MAIN OBJECTIVES**

**NACID** is:

- The leading institution in the national information infrastructure in Bulgaria in the sphere of education, science and innovations.
- National information center for academic recognition and mobility (ENIC-NARIC center for Bulgaria).
- Contact point to the Directive 2005/36/EC on the recognition of professional qualifications and delegated coordinator for Bulgaria in Internal Market Information (IMI) system.

**PRIMARY FIELDS OF ACTIVITIES**:

- Processing and dissemination of bibliographic and reference data and analytical information in support of the policy in the sphere of education, science, technology and innovations.
- Building and maintaining specialized databases.
- Maintaining national stock and DB of dissertations,deposited manuscripts and other scientific publications in Bulgaria.
- Organizing application of ENIC-NARIC network decisions in the field of academic recognition.
- Realizing information assistance in procedures for academic and professional recognition.
- Performing activities resulting from the functions of ENIC-NARIC center.
- Furnishing citizens and contact points in the rest of the member states with information in connection with recognition of professional qualifications and rights for practicing regulated professions in conformity with the Directive 2005/36/EC.
- Performing functions of institutional contact point of the EU's Seventh Framework Programme.

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**"Bulgarian Science" Databases**

- *"SIRENA",* R&D *reports and dissertations*;
- *"Scientific and Technical Publications in Bulgaria"*;
- *"Register of the Scientific Degrees and Titles";*
- *"Who is Who in Bulgarian Science*;
- *"Papers".*

**"Science and Industry" Databases**

- "*Partnership for Innovation and Development";*
- *"Knowledge for Innovations and Development"* .

Information brokerage and servicing from external databases gives access to over 1200 databases of the leading information centers, including STN International – Germany, DIALOG – USA, EBSCO, etc.

- **Library Services**

**Central Research and Technical Library (CRTL)** with library information complex in pedagogics is one of the largest Bulgarian libraries and main supplier of information in the field of science, education, pedagogics, engineering, technology and economy with more than 4 million registered items, including books, periodicals, dissertations, publications on CD ROM, DVD. It offers:

- Lending of library materials;
- Online access to the library catalogues since 1980;
- Searching in electronic catalogues and databases;
- Electronic Document Delivery;
- Interlibrary loan.

**INTERNATIONAL ACTIVITY**

- Represents the Republic of Bulgaria in international organizations on the subject of its activities.
- Joint actions and projects with related national information and documentation centers in the EU.

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# NATIONAL SCIENTIFIC PROGRAMMES WITH EUROPEAN DIMENSIONS

## PROTEOMICS OF HEART DISEASE AND HEART FAILURE

**Nina Gotcheva[1], Iliana Petrova[1], Nadya Ivanova[2], Katya Gancheva[2], Iva Paskaleva[1], Dobrin Svinarov[3], Margarita Apostolova[2]**

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***Abstract***

*Heart diseases resulting in heart failure are among the leading causes of morbidity and mortality in all countries of the world. Underlying molecular bases of cardiac dysfunction in most heart diseases are still largely unknown but are expected to result from alterations in gene expression and protein function. The data of genome sequences from human and other species have demonstrated the complexity of biology, including the finding that one gene does not encode for only one protein but for several, due to mRNA splicing and post-translational modifications. The rapid development of proteomics technologies and the resulting diversity and complexity of proteomics data poses special challenges. In particular, methods for structuring and searching proteomics databases to retrieve groups of proteins based upon well-known pathways, functional classifications and specific post-translational events must be developed. The combination of these approaches has proved to be particularly interesting for studying cardio-vascular diseases and thereby improving the understanding of the mechanisms involved and identifying new biochemical factors and biomarkers involved in heart failure, which is the end-stage of practically all cardio-vascular diseases.*

### INTRODUCTION

Advances in diagnostic procedures and therapeutic options over the last decade have made cardiovascular medicine an exciting area in which to work as a clinician. Inevitably, they have also added to the breadth of knowledge a doctor needs to provide the best care for the patient. A major determinant of outcome for patients with heart disease is the degree of damage to their heart, reflected in the clinical syndrome of "heart failure". Our understanding of the nature, the extent in the population, and therapy of heart failure has grown considerably. Nevertheless, the heart failure is the main health and social problem and the main cause of morbidity and mortality all over the world. Still more controversial has been the detection of impaired overt symptoms. Screening of patients with any cardiovascular disease with simple and reliable tests to detect the risk of heart failure development is important and also could be a key to find an appropriate remedy recognizing the heterogeneity of the causes. It is also essential to realize that the progression of the heart failure itself is the result not only from the hemodynamic changes, but from complex interaction between genetic, neurohormonal, inflammatory and biochemical changes and influences. The molecular mechanisms responsible for heart dysfunction are still largely unknown, except in cases of ge-

netic defects or alteration of genes and proteins.

**GENOMICS OF HUMAN HEART FAILURE–STATUS AND PROBLEMS**

Publications during the recent years of genome sequences from humans and other species have demonstrated the complexity of biology, including the finding that one gene does not encode for only one protein but for several due to mRNA splicing and post-translational modification in cases with heart failure [1, 2, 4]. The complete sequencing of the human genome in 2001 showed that fewer than 3000 genes encode more than million proteins. Classical strategies have measured mRNA transcripts or proteins according to a prior hypothesis based on literature reviews [3]. Because of the need for global approaches without any a priori hypothesis, techniques were developed for analyzing genes (genomics), mRNA (transcriptomics), proteins (proteomics) and metabolites (metabolomics). These techniques should make it possible to elucidate the functional role of several genes or gene products and thus better understand phenotypes linked to various types of disease status [2, 3, 5]. Gene array technology in failing human hearts is now well advanced. It is based on transcription of either short oligonucleotide or long cDNA nucleotides. Two DNA microarray technologies are currently in use for the study of human disease and for the study of heart failure. But the assumption that in practice each probe quantifies the expression of the corresponding gene may be overly simplistic. The data show that the correlation between the quantity of mRNA and the quantity of the corresponding protein can be poor. That is why the major advantage of DNA microarray technology lies in the ability to profile and compare thousands of genes simultaneously between several mRNA populations. However, the utility of the DNA microarray extends beyond the concept that it is a novel tool for large-scale transcript profiling and identifying differences in expression between single genes. From clinical point of view the usefulness of gene analysis is mainly connected to define the biological pathways and clusters of genes related to the etiology of heart failure. Hence, it is possible to make differentiation between heart failure due to either idiopathic dilated cardiomyopathy or to coronary disease complementing different techniques for better understanding the underlying phenotype [7, 8, 9].

**PROTEOMICS OF HUMAN HEART FAILURE–ADVANTAGES AND IMPLEMENTATION**

Proteomics differs from genomics in both complexity and dynamic variability. Whereas the genome is relatively constant, the proteome is constantly changing according to the moment interactions between the genome and the environment. Recent studies made it clearer that the importance of measuring proteins becomes more and more important for the practice. Proteomics differs from traditional "protein chemistry" in studying the interaction of proteins within an organism. It differs also from "metabolomics" or the so-called metabolic profiling focusing on the protein enzymatic actions on the energetic substrates. The notion of cartography for protein level expression is an old one, dating back to the publications of a technique to separate proteins simultaneously in 2D electrophoresis gel. The term "proteome" was first used in 1994 by Wilkins and defined as all proteins expressed by a genome, cell or tissue. There is an important contribution of proteomic analysis to studying the functional diversity of genomic expression (Fig. 1). Differential proteomics is the comparison of protein profiles from various samples obtained in different conditions to identify proteins differentially expressed without any a priori hypothesis. Proteomics in this context is an expression, function and interaction of the complement of proteins in an organism in health and disease. In part they reflect the genome, but they also mirror changes due to further cellular processes resulting in co- and post-transitional modification events [1, 4, 9]. The excitement surrounding proteomics focuses on the potential to elucidate the molecular mechanisms that control normal cell and organ function as well as the potential to identify proteins responsible for initiation and progression of disease. In this respect, the proteins that change as well as those that do not are key to our understanding of the subtle and complex manner in which the cells adapt to pathophysiological stimuli resulting in disease. This is especially true with heart failure being

complex multi-factorial disorder ultimately diagnosed on the basis of the inability of the heart to maintain sufficient cardiac output to meet the metabolic needs of the body. There are many sub-proteomes within cardiomyocytes capable of causing reduced cardiac output. Proteomic analysis can help in sorting out which families of proteins are affected. The ultimate goal of proteomic studies is to differentiate protein changes that are causative versus those that occur as a result/effect of the disease. Hence, there still are two main goals that have to be elucidated, and this is the difference between cause vs. effect reflected by the type of proteins. One of experimental strategies addressing the issue cause/effect is based on the idea that proteins are altered during the early phase of initiation or trigger of heart failure and subsequently protein changes are aggravated. This hypothesis could be a key to understanding the cellular dynamics and interconnections. To obtain this information a temporal proteome profiling of the human myocardium during the heart failure development should be carried out, which is rather difficult and practically not possible. An alternative strategy is then required, and it is connected to performing proteomic analysis of the same disease produced by different triggers based on the assumption of the overlapping protein changes. These represent convergent points or same end-effectors of the phenotype. It is supposed that the underlying common mechanisms may reveal pathways or groups of proteins/targets for therapeutic intervention. One must remember that in some patients the same end phenotype or function may be connected to different groups of proteins. In the heart contractile dysfunction can arise either through a change of Ca-handling proteins and/or the contractile/myofilament proteins. Many studies concerning proteomic analysis of human end-stage heart failure have been published. Major limitation of all data analysis is the lack of large numbers of clinically defined failing hearts [4, 7, 8].

Proteomics is a potential tool for discovery and application of novel biomarkers in diagnosis of the inception and progression of heart disease, which might affect prevention and therapy and also if it is in close relation with the clinical appearance of heart failure. Proteomic biomarkers differ from traditional biochemical markers that we use clinically, in that multiple interacting protein species are evaluated simultaneously to reflect the response of a cell or an organism to disease or adversities in the environment. One major benefit of the different methods for proteomic analysis is the potential for a greater

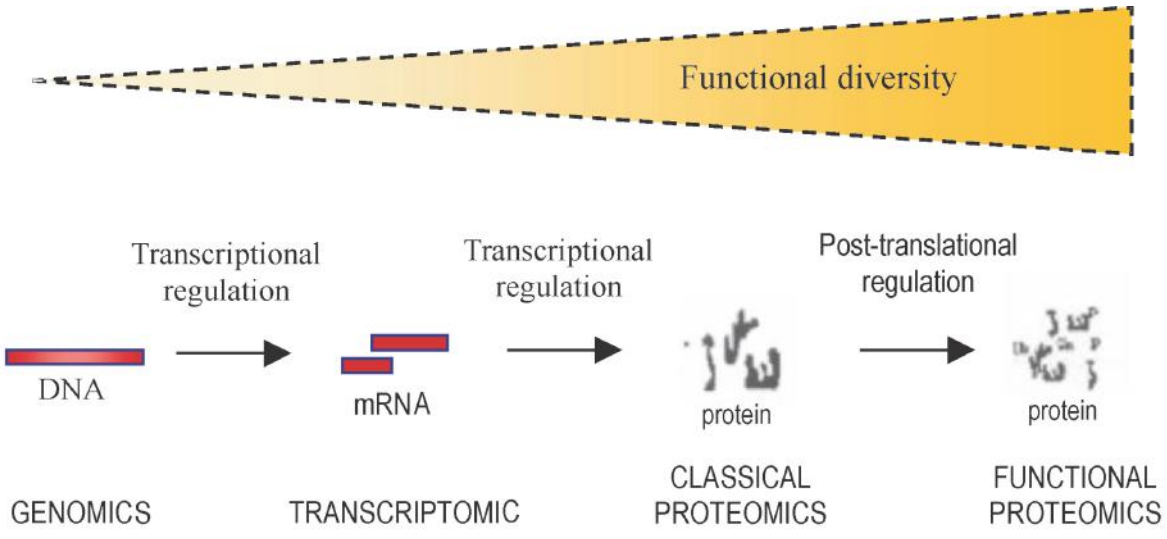


**Fig. 1.** Contribution of proteomic analysis to studying the functional diversity of genome expression. Inverse correlation between the complexity of biology and technology.

understanding of the cellular processes that are responsible for the transition to disease phenotype. By profiling the changes in the detectable protein pool of the heart it is possible to evaluate the changes in critical pathways that might be present early in the disease process, before the onset of clinical symptoms or functional disturbances and during disease progression. The data from proteomic studies could be helpful to distinguish etiological background, pathophysiology and also prognosis of heart failure. The methods for proteomic analysis have the potential to improve biological understanding and evaluation of heart failure, as well as they may create a complex network of novel biomarkers. Only a handful of biomarkers such as troponin for acute coronary syndrome or brain natriuretic peptide for acute heart failure are currently used to diagnose or prognosticate individual patients. The most attractive was the idea of biomarker-guided heart failure treatment. Adding to a mixed evidence base regarding the use of natriuretic-peptide levels as a treatment target in patients with heart failure, the results of the latest randomized trial (TIME-CHF) have suggested that the appealing but unproven strategy has little or no effect on survival overall, especially in the oldest patients. Whereas – as TIME-CHF suggests – it may reduce the risk of heart failure hospitalization in younger patients who are already well managed pharmacologically by conventional standards [5, 10].

**PROTEOMICS PERSPECTIVE**

The approach of biomarker identification shifts now from large-scale epidemiologic associations to association between the disease phenotype and specific genomic or proteomic patterns. These novel biomarkers can be developed for increased precision in diagnosis, identification of susceptibility to complications and prognosis in patients, as well as for identification and subclassification of disease on the basis of pathophysiological manifestations. Because individual biomarkers will have limited sensitivity and specificity, proteomics affords the opportunity to identify a panel of complementary biomarkers that will have more robust operational characteristics. The data from clinical studies combined with data obtained from experimental animal models could lead to novel insights into the biology of the heart failure. Additional assessment of new biomarker pathways should identify novel targets relevant to the disease. Medical diagnostics will most likely be the first goal to be achieved by proteomic technologies. It will probably take longer to evaluate therapeutic target function and identify safe and effective modulators that are suitable for clinical development. So far, of the 70 proteins that showed quantitative changes in the failing heart, 42 were present at reduced abundance, while 28 were increased. After identification, these proteins were assigned to three broad functional classes: 1. proteins associated with mitochondria and energy metabolism; 2. cytoskeletal and myofibrillar proteins; and 3. proteins associated with cellular stress responses [8, 9].

**CONCLUSION**

Taking into consideration all approaches to solving the problem inherent in the genomics and proteomics of heart failure, additional information about protein localization, function and binding partners must be obtained. The goal of the next steps in the field of proteomics is to provide understanding of the exact proteome and of functional changes associated with heart failure, regardless of the triggering etiology. The results of these studies, when combined with genomic data, might help for identification of pathways that render the heart incapable to maintain the cardiac output. A collective understanding of the proteins involved in the genesis of heart failure will enable the design of new treatments and clinical interventions.

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# SUB–MICRON MACHINING AND ANALYSIS OF MATERIALS AND STRUCTURES USING SCANNING ELECTRON MICROSCOPY IN COMBINATION WITH FOCUSED ION BEAM

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***Abstract***

*The goal of this paper is to present the infrastructure project DO 02-56/2008 "Sub-micron machining and analysis of materials and structures using scanning electron microscopy in combination with focused ion beam" financed by the National Science Fund (NSF) of Bulgaria.*

*This project is to secure funding for the purchase of a dual-beam Scanning Electron/Focused Ion Beam Microscope (SEM/FIB) with low pressure capability and attachments for energy dispersive X-ray microanalysis (EDX). This versatile apparatus will enable state-of-the-art research to be carried out by researchers in a number of scientific fields in Bulgaria.*

*The versatile capabilities of this equipment are the reason for an interest in and support for it from a number of scientific groups from Sofia University "St. Kl. Ohridski", the Geology and Mining University, the Transportation Institute, Bulgarian Academy of Sciences (BAS) the Microbiology Institute and the Institute of Solid State Physics, and the Medical University, from various scientific areas (physics, chemistry, mineralogy, biology, medicine, etc.). The expected deliverables are that the availability of such a unique apparatus will significantly broaden the scientific research in these areas, by providing locally capabilities that were previously available only through international collaborations.*

## INTRODUCTION

Scanning Electron Microscopy (SEM) with secondary electron (SE) detection is one of the most widely used techniques for microscopic surface characterization [1, 2]. Complementing the system with other detectors such as Energy Dispersive X-Ray (EDX), Wavelength Dispersive X-ray (WDX), Electron Backscattered Diffraction (EBSD), Electron Beam Induced Current (EBIC), Cathodoluminescence (CL), Gas Injection System (GIS) etc., can enable high spatial resolution 2D imaging of chemical and physical properties of a sample. While the main purpose of SEM is *characterization*, a focused ion beam allows *modification* of the sample – local sputtering or deposition of material at the sub-micron scale [3-7]. The combination of an independently controlled electron and ion beam in the same apparatus (developed and marketed recently by several companies) allows simultaneous modification and characterization of the sample at the sub-micron level. A low pressure gas environment (as opposed to ultra high vacuum) enables work with hydrated and isolating materials, such as biological, environmental, or dielectric samples [2].

The versatile capabilities of this equipment are the reason for the interest and support from the consortium of six different institutions. The expected deliverables are that the availability of such a unique apparatus will significantly broaden the scientific research in the respective

fields, by providing locally capabilities that were previously available only through international collaborations. Scientific activities of the research teams are multi-disciplinary and will utilize the proposed equipment's capabilities in the following priority science areas: New materials and nanotechnology; Biotechnology, foods and health; Ecology, bio-diversity and biological resources.

The paper is organized as follows. First, the aims of the project and scientific institutions and groups, which constitute the consortium, are briefly presented. Then the members' research fields and how this project is expected to contribute to them are considered. Finally, current stage of the project is reported.

**AIMS OF THE PROJECT**

The main aim of the project is to ensure a modern multifunctional and unique in Bulgaria equipment – dual beam Scanning Electron/Focused Ion Beam Microscope (SEM/FIB) with a number of additional options, like EDX, low-vacuum regime, etc. Scientific results in various research fields - physics, chemistry, materials science, microbiology, geology, etc. are expected due to different research interests of the members and to the various potentials of the equipment. The project will contribute to further widening of the existing and creation of new collaborations inside and outside the team.

The SEM/FIB/EDX equipment can be used to investigate in practice any material and structure. The capabilities of using several methods for imaging and characterization combined with material machining facilities in one dual-beam equipment (developed and marketed recently) can be found in few research centers in Europe. This makes such equipment extremely valuable in physics, chemistry, biology, geology, materials science, micro- and nano-technology, etc, and its possession will make the members of the team sought after partners in large scientific national and international projects.

During and as a result of the project realization it is expected that the potential of the teams to carry out the ongoing projects and fulfill the existing research plans will increase. New research areas will be accessible experimentally like MEMS, microfluidics, 2D and 3D structures (FIB, FIB+GIS). Closer contacts between the institutions will be established contributing to interdisciplinary research and for future research projects.

Another important goal is modernization of the educational process by introducing new students' practical exercises on SEM, FIB and X-ray microanalysis in the curriculum (Dept. Solid State Physics and Microelectronics and possibly other universities). Creation of a favorable scientific environment for young scientists will be a great benefit from this project. Ten young researchers are members of the team – 23% of the members of the project team. In the preliminary agreements it is foreseen that all of them (including future PhD students of the members) will have access to the equipment. Part of the results obtained using the equipment is expected to be presented at international meetings and conferences with funding provided by this project. The results will also be included in publications and PhD and MSc theses. A part of the future PhD and MSc projects will be influenced by the access to modern methods and technologies that the new equipment will make available. We expect that the opportunity to work with high technologies and modern equipment will be part of the incentive for more young people to choose the career of scientists.

**THE CONSORTIUM MEMBERS**

Because of the interdisciplinarity of the project it is carried out by a relatively large consortium, comprising six scientific organizations: Sofia University "St. Kliment Ohridski" (host organization, participating with 4 faculties – Physics, Chemistry, Geology and Geography, Biology, and Medical), the Institute of Microbiology - BAS, the University for transport "Todor Kableshkov", the University for Mining and Geology "St. Ivan Rilski", and participants from the Institute of Solid State Physics-BAS and the Medical University - Sofia. Total number of individual members of the consortium is 44. As already mentioned above, young researchers are well represented in the team – 23% of the members of the project team.

**MEMBERS' SCIENTIFIC FIELDS**

• Sofia University "St. Kl. Ohridski", Faculty of Physics and Faculty of Chemistry

The members of the team from Faculty of Physics, Sofia University "St. Kl. Ohridski" are more than those from other organizations and include people from different departments and scientific groups: Department of Solid State Physics and Microelectronics, Department of Condensed Matter Physics, Department of Quantum Electronics, Department of General Physics, Department of Physics of Semiconductors, Department of Nuclear Engineering, Center for Cosmic Investigations and Technologies. Their research areas include in practice all parts of physics and the fact that they are interested in acquiring the equipment from the present project is yet another proof of the various opportunities that it provides.

The Faculty of Physics is, thus, the more suitable and natural place for the equipment. We intend to install the equipment in the Laboratory of Materials Technology of the Dept. of Solid State Physics and Microelectronics, Faculty of Physics. The Laboratory is founded in 2007 on the basis of several former laboratories and at the moment it is in possession of diverse equipment for thin film deposition - electron beam evaporation, thermal evaporation, DC and RF sputtering, spin-coating, and with specialists skilled in exploitation and maintenance of such complex equipment. The new equipment will allow new results to be obtained - microanalysis of structures, further work on nanostructure ordering, obtaining and investigating of structures with developed surface for sensor applications, etc.

The group from the Department of Solid State Physics and Microelectronics is in possession of a Hitachi S750 SEM. Its electronics and software were updated on the base of original contributions [8] and now the equipment is with digital registration of images and the position of the electron beam is controlled by a computer. The latter option was used to create a system for electron beam lithography (EBL) - Fig. 1 [8]. Recent activities of the group include using EBL and SEM for 2D EBL controlled ordering of silver nanostructures [9], high surface to volume ratio structures and multilayered structures for polarization applications [10].

Members of the team from Dept. of Solid State Physics and Microelectronics, in collaboration with the Applied Optics Group of the University of Nottingham, work on the increase of the resolution and sensitivity of plasmon microscopy and sensitivity [11, 12], and resolution of 0.3 μm is achieved. Plasmon based sensors

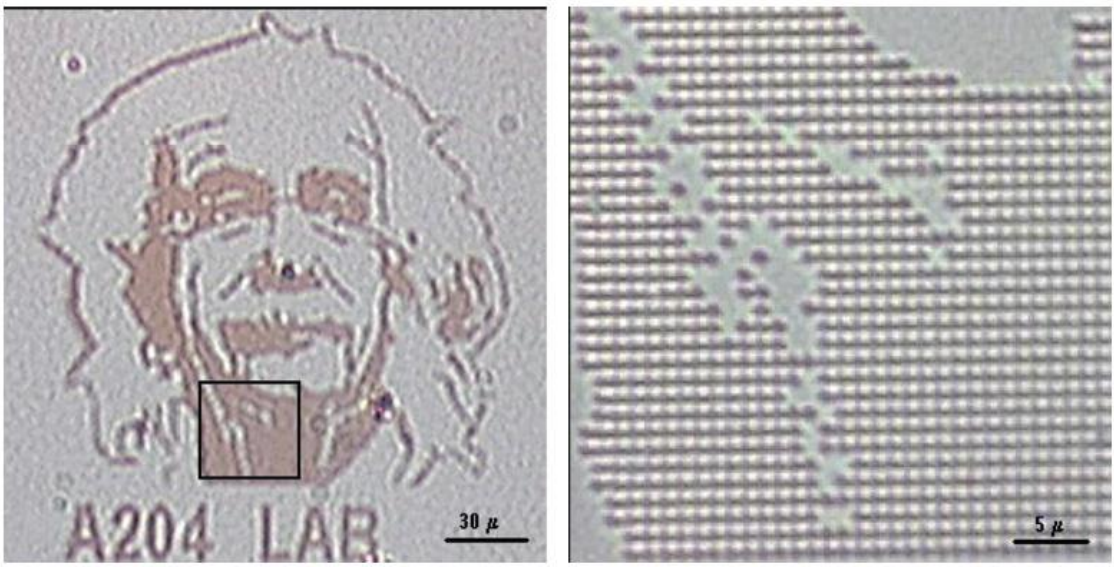


**Fig. 1.** SEM based electron beam lithography - PMMA/Au. The resist (PMMA) was exposed at an accelerating voltage of 20 kV and a point dose 40 fC. The scale bar is 30 μm (left) and 5 μm (right).

are among the most often used optical sensors. Besides, plasmonics is a rapidly developing field and there is much hope that it will allow further miniaturization of the components and increment of the speed of optical information processing. Up to now, the investigated samples were made by third parties but the availability of SEM/FIB in Sofia University "St. Kl. Ohridski" will allow more flexibility and freedom in fabrication of the necessary structures. The same group collaborates with the section "Morphology of Microorganisms and Electron Microscopy" from the Institute of Microbiology and colleagues from the University of Chemistry, Technology and Metallurgy, Sofia in the investigation of biofilm formation with plasmon microscopy and spectroscopy in the frame of projects from NSFB (L-1402/04; VUTN-213/06). Apart from the problem with dehydration, explained in the next section, FIB will allow fabrication and inclusion in the investigation of new elements of microfluidics appropriate for high through output sensors.

**• Bulgarian Academy of Science (Institute for Microbiology); Faculty of Medicine, Sofia University "St. Kl. Ohridski"; Medical University**

Modern medicine is facing the spread of biofilm-related infections. Biofilms that form on indwelling medical devices (urinary or venous catheters, mechanical heart valves, pacemakers, contact lenses, etc.) may be a serious risk for the patients. An opposite aspect of biofilm nature is their application in biotechnology: development of microorganisms immobilized on different carriers, and lately – on nanomaterials applicable in the production of bioactive substances, water purification, etc.

One important approach to biofilms is scanning electron microscopy. This method has certain limitations due to the need of dehydration of samples in conventional SEM methodologies. An exception of this condition is the specimen chamber of a low vacuum (environmental) SEM. The presence of gas around the sample creates new possibilities unique to this type of instruments. Hydrated specimens can be examined as they are in their natural state, without any modification of the surface like metal layer sputtering as it is in a standard SEM. The team from the Department of Morphology of Microorganisms and Electron Microscopy, Institute of Microbiology, Bulgarian Academy of Sciences, is presently participating in two projects in this regard: NT2-02/05 and VU-L-321/07. The second project is in collaboration with the Department of Solid State Physics, Faculty of Physics, and Sofia University "St. Kl. Ohridski". Both projects rely greatly on SEM, and will benefit greatly from the new equipment (especially low pressure option).

**• Sofia University "St. Kl. Ohridski" (Faculty of Geology and Geography, Faculty of Physics), University of mining and geology.**

**Application to petrology and mineralogy**

The appearance of the X-ray microanalyzer technique revolutionized petrology and especially metamorphic petrology. The technique was a prerequisite for establishing the zone distribution of metamorphogenic minerals, especially with regard to their chemical content. Nowadays, chemical data obtained by microprobes from rock-forming minerals are used as indicators for the thermal and pressure conditions of rock formation. These data are the basis for analysis of the evolution of the corresponding segment of the Earth's crust.

Electron microprobe analysis is a basic method for phase diagnostic of submicron inclusions of minerals in petrology and mineralogy [13] and is applied in almost all areas of geology and even in cosmic investigations [14, 15]. It has also applications in geochemistry and mineralogy for express quantitative chemical analyses of large samples and microscopic inclusions [13]. Such analyses are also very important for the educational process and they find applications in MSc and PhD theses in geology, chemistry, biology, archeology and physics. The X-ray microanalysis (EDX) and FIB in the equipment, envisaged to be bought, will allow also depth microanalysis.

The electron/ion beam microprobe is intended to be used for measurement of anthropogenic contamination in sediment layers by heavy metals (Pb, Ba, Sr, and U). These data allow chronographic reconstruction of the contamination process in past time, for which there is scarce or missing documentation and direct measurements. Pb, Ba, and Sr are deposited in

calcite fractions of the crust through ion exchange [16], while U causes the formation of metamictic layers in the minerals.

Most of the participants in the consortium have productive domestic collaborations among themselves, which have resulted in co-author publications, common scientific projects, and other collaborative scientific activities. Members of the team also have numerous international collaborations.

**CURRENT STAGE OF THE PROJECT**

This is the first year of the two-year project and the most important task for its successful completion is acquiring of the envisaged instrumentation. This includes basic SEM/FIB microscope with technical specifications and options that matched closely the diverse specific requirements, dictated by the broad range of scientific areas of the participants. After the start of the project the first meeting of the consortium was held with main purpose to discuss these topics.

The combination of several methods and options in one apparatus is economically, scientifically and practically favorable and justifiable. Acquiring SEM and FIB as different machines will increase the investments and make the maintenance more difficult and more expensive. Such a solution implies moving the samples between the machines which greatly limits the potential applications compared to the dual beam configuration. So the last was chosen as a basic configuration.

The potentials of the proposed configuration have been discussed with the participants in the project in order to meet their specific scientific requirements and needs. SEM will be useful to all team members, while low pressure option is mainly of interest for biologists (Institute of microbiology, BAS; Faculty of Medicine, SU "St. Kl. Ohridski"; Medical University), but also for people investigating nonconductive sample since no additional conductive layer covering is necessary in this regime. X-ray microanalysis in combination with FIB allows not only 2D analysis but also 3D and depth analysis, and without any doubt will raise the research level in solid state physics, physics of semiconductors, materials science, micro- and nanotechnologies (Faculty of Physics and Faculty of Chemistry, SU "St. Kl. Ohridski"; Institute of Solid State Physics, BAS; University of transport) and geology (Geology and Mining University; Faculty of Geology and Geography, SU "St. Kl. Ohridski").

Based on these discussions the documentation for a public procurement procedure was prepared. A tender for the instrument supply and installation was won by the company TESCAN s.r.o. with a base model LYRA I XMU [17]. This is a dual beam SEM/FIB configuration with low vacuum and EDX options included. According to the contract with the supplier it is expected that the delivery and installation of the instrument will be in October 2009. Training of two operators will be held after installation by the supplier specialists.

Meanwhile preparation of the installation place for the instrument is conducted to fulfill the manufacturer's requirements.

**CONCLUSION**

The combination of FIB and SEM in one dual-beam system offers unique capabilities for simultaneous machining, imaging and analysis, and is principally a new machine. The selected configuration comprises SEM/FIB + EDX, low pressure regime and possibilities of adding additional modules: gas injection system (GIS), cathodoluminescence (CL), electron backscattered diffraction (EBSD), electron induced current (EBIC) and will be beneficial for the state-of-the-art research carried out by researchers in a number of scientific fields in Bulgaria.

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# ARCHEOMETRIC INVESTIGATION OF THE GOLD IN THE CHALCOLITHIC NECROPOLIS OF VARNA (5$^{TH}$ MILLENNIUM BC)

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***Abstract***

*In the autumn of 1972, during industrial excavation works at the Varna Lake coast, the archaeological discovery of the 20$^{th}$ century European prehistory was made. The archaeological excavations carried out during 1978-1992 discovered unveiled 298 funerals. They contained, besides ceramics, coppers and other objects presenting an exclusive interest for scientific investigation of the prehistoric society, also a variety of gold finds. The number of gold finds is above 3000 with more than 6 kg weight!*

*Geological survey on the possible sources of gold in the territory of Southeast Bulgaria will be carried out. Using optical microscopy, electron microprobe and X-ray diffraction the chemical and mineralogical composition of the samples gathered from the river stream sediments will be determined. At the same time using nondestructive X-ray fluorescence the main composition (the content of gold, silver and copper) of the more than 3000 gold finds in the Chalcolithic necropolis of Varna will be determined. Using mass spectrometry with inductively coupled plasma and laser ablation as well as mass spectrometry with inductively coupled plasma after solving of the small quantity of samples taken from the gold artifacts the concentration of microelements will be determined. Comparing the data of concentration of the chemical elements in archaeological and geological samples using cluster analysis, descriminant analysis and analysis of mean components, the similarity as well as desimilarity between geological and archaeological samples will be evaluated. On this base local sources of natural gold used for production of the gold artifacts from the necropolis of Varna could be found.*

*Thus for the first time the sources of natural gold used for production at least of a part of gold artifacts from the oldest worked gold in the world will be determined.*

*In the present paper the work program of the proposed project for investigation of the gold from Chalcolithic necropolis of Varna is*

*described, as well as briefly the previous studies of the Varna gold are presented.*

**INTRODUCTION**

Although the first archaeometric investigations for determination of chemical composition of archaeological finds from the time of Ancient Greece and Roman Empire were carried out by the German chemist and pharmacist Heinrich Martin Klaprot at the end of the 18th century (see e.g. [Caley, 1949]) and during the 19th century a big part of the leaders in chemistry and physics were involved in such kind of archaeometric investigations, archaeometry as a scientific field is relatively new one, and in the aspect of today appeared after the end of the Second World War. Archaeometry is accepted today all over the world in a number of universities and scientific institutes. This interest was engendered by the wish to use the achievements of natural sciences with the aim to receive new data and results about materials discovered in the archaeological excavations, which is not possible to be obtained with archaeological methods of investigations. This objectively obtained information about the technological level of development of the human society and the way of distribution of knowledge about different production methods allows creating a real image about the structure and development of the ancient human society.

The first archaeometric investigations in Bulgaria started with the study of the production of iron at the Bulgarian region [Бончев, 1920; Георгиев, 1978; Иречек, 1899; Коняров, 1958, Караиванов и др., 1968; Трифонов, 1924; Трифонов и др., 1964]. As it is seen from this incomplete citing, these investigations started from the end of the 19th century and continued to the end of the 70-ies of the 20th century. But during this interval there also appeared studies about recovery of gold (see e.g. [Георгиев, 1987; Караогланов, 1923/24]).

After the end of the World War II a number of Bulgarian archaeological finds are investigated using different methods. Among them the investigation of glass could be pointed out [Безбородов & Маринов, 1958; 1960; 1961a; 1961b; Kuleff & Djingova, 2002], and later of pottery [Кулев, 1997; Guzowska et al., 2003; Kuleff & Djingova, 2001], copper and bronze [Черных, 1978; Pernicka et al., 1997], bones [Zlateva et al., 2003], amber [Kuleff et al., 2002; Ivanova & Kuleff, 2009], etc. Information about archaeometric investigations carried out at the Faculty of Chemistry of the Sofia University "St. Kl. Ohridski" could be evaluated from the paper published in the most valuable journal in the field of archaeometry [Kuleff & Djingova, 2007]. This incomplete enumeration of archaeometric investigations carried out in Bulgaria or with participation of Bulgarian scientists shows that the investigations in this field are not extrinsic for those working at Bulgarian universities and scientific institutions, and had found their place in scientific literature.

At present the work started on the project financially supported by the National Fund of Scientific Investigations to the Ministry of Education and Science (NFSI) having the aim to determine chemical composition of the numerous gold finds in the Chalcolithic necropolis of Varna, as well as to try and find the sources of gold used by ancient goldsmiths for production of these oldest manufactured gold samples in the world.

**ARCHAEOMETRIC STUDIES ON GOLD AND GOLD FINDS IN BULGARIA AND EUROPE A PROBLEM OF THE PRESENT DAY**

The study of the archaeological gold finds is of great interest, based on the need to solve the following problems:

a) where are the sources of gold, used by the ancient goldsmiths;

b) what are the technologies used in the past.

Accumulation of archaeometric data for authentic archaeological gold finds is the only way to identify objectively the fakes among the finds circulated in the last 20 years in Bulgaria and all over the world (see e.g. [Aurum, 2009; Eugster et al., 2009; Kossolapov & Chugunova, 2002]).

Despite the great interest for the gold archaeological finds not only in Bulgaria but elsewhere too, archaeometric publications in this respect are not numerous. This is caused on one hand by the strong limitations for acquiring samples from the gold archaeological finds (as a rule they are objects of exceptionally high value), and on the other the difficulty to carry out a

non-destructive analysis aiming to determine the origins of the raw gold, used in their manufacturing. In fact applying a non-destructive analysis is difficult because the methods to be used are activation analysis with accelerated protons or alpha particles (see e.g. [Cojocaru et al., 2003] and/or gamma-activation analysis. These methods require accelerators and very expensive equipment and this is only possible in a few places worldwide. A possible solution, positioned between the destructive and semi-nondestructive analysis, is laser ablation mass spectrometry with inductively coupled plasma (LA-ICP-MS).

Recently several scientific publications appeared [Gondonneau, et al., 2001; Guerra, 2004; 2005; Guerra & Calligaro, 2007; Junk & Pernicka, 2003], where, based on a precise chemical analysis of gold of archaeological finds, the authors reach certain conclusions about the origins of the gold used for their manufacturing. In parallel several reports on gold archaeological finds studies were discussed in the last year at scientific conferences [Archaeomet, 2008; Archaeometallurgy in Europe, 2007; Archaeometry, 2008; Aurum, 2009].

The last couple of years the interest in Bulgaria for the numerous gold archaeological finds has been expressed in two projects, proposed and supported by the NFSI, aiming to investigate archaeological gold-finds. However their target is to present chemical composition data about the studied objects, conserved in the National Archaeological Institute with Museum of Bulgarian Academy of Sciences (NAIM-BAS), or to present certain information about the gold objects manufacturing methods used for production of gold finds from Varna Chalcolithic necropolis. It is important to underline that because of the used methods none of them is in a position to answer the basic question – ***Where did the raw gold used in production of archaeological finds come from?***

To these should also be added determination of chemical composition of gold breastplates from the IV century BC, kept in NAIM-BAS, [Kuleff et al., 2009).

**DISCOVERING OF VARNA GOLD**

In the autumn of 1972, during industrial excavation works at the Varna Lake coast, the archaeological discovery of the 20$^{th}$ century European prehistory was made. Very soon thereafter it became known as the „Golden Eneolithic necropolis". The archaeological excavations carried out during 1978-1992 discovered unveiled 298 funerals. They contained, besides ceramics, coppers and other objects presenting an exclusive interest for the scientific investigation, also a variety of gold finds.

The number of the Varna necropolis gold finds is above 3000, while they weigh more than 6 kg [Ivanov & Avramova, 1997]. In comparison, the synchronous gold finds from the whole world can be counted by the fingers of one hand and have total weight measured in grams. Particularly impressive and with nothing similar all over the world are the archaeological complexes: Grave 1 (216 gold finds with total weight 1.092 kg); Grave 4 (339 gold finds with total weight 1.518 kg); Grave 36 (857 gold finds with total weight 0.789 kg); Grave 43 (990 gold finds with total weight 1.516 kg). The Varna gold is determined, according to the dating of the necropolis materials (see e.g. [Ivanov & Avramova, 1997; Higham et al., 2007]) as the oldest worked gold worldwide (second half of the 5$^{th}$ millennium BC) (see [Тодорова 1986; Gorsdorf & Bojadziev 1997; Renfrew, 1978]). Its huge amount is one of the arguments for the assertion that here we deal with the oldest world civilization, characterized by a complex hierarchal social structure.

I would like to mention here that there are two main hypotheses about the gold sources of Varna. The first one, supported by many archaeologists, insists that the metal is extracted from the present-day Bulgarian territory. The supporters of this opinion point out many geological and archaeological arguments. The second hypotheses, supported mainly by scholars not really familiar with Balkan prehistory and chronology, claims, that the origin of Varna-gold was Caucasus or the Carpathians.

Solving the problem about the origins of the Varna Chalcolithic necropolis gold is one of the preconditions for clarifying the mechanisms and the ways of accumulation of this colossal for its time wealth and the causes for appearance of this proto-state structure emerging at the Black

Sea coast during the second half of the 5th millennium BC. This exactly is one of the reasons for this investigation, aiming to realize the first truly comprehensive study of the Varna necropolis golden objects, using up-to-date equipment and resulting in the discovery of the gold origins.

**PREVIOUS STUDIES OF THE VARNA GOLD AND ITS POTENTIAL SOURCES**

A single study of the Varna necropolis gold finds chemical composition is known so far [Hartmann, 1978]. Hartmann analyzed around 100 gold finds using atomic emission spectrometry with possibilities much below the ones available in today's analytical chemistry [Hartmann, 1978]. In addition Hartmann's work [Hartmann, 1978] does not comprise analysis of gold ores or alluvium gold samples, which could be potential raw material sources. His conclusions about the possible gold source, that supplied the production of such a huge quantity of objects, are based on most general considerations and knowledge concerning the South East Europe gold deposits and those in the neighboring regions. From today's point of view Hartmann's study is not only incomplete, but it is even misleading by its not sufficiently augmented conclusions.

A second study of the Varna necropolis gold has been carried out at the end of the 80's, but it concerns only the technology of two unique vessels  the big ceramics cup and a small vessel with cover from Grave 4, painted with gold powder [Éluère & Raub, 1991; Ivanov & Avramova, 1997]. Five samples from the gold plating amounting to about 400 micrometers square and with a mass of few micrograms (n.$10^{-6}$ g) have been subjected to a microsection metallography, semi-quantitative spectral analysis, scanning electron microscopy (SEM), including energy-dispersive X-ray fluorescence analysis (ED-XRF) [Éluère & Raub, 1991]. The gold plating chemical composition so analyzed is: 5 to 7% silver, around 0.6% iron and less than 0.5% copper. The authors [Éluère & Raub, 1991] conclusion from these results concerning the gold plating chemical composition is that the instrument was made of natural alloys of gold and silver. The gold particles show typical alluvial gold shape and size; therefore gold was obtained by panning river sands.

Some of the gold finds from Varna Chalcolithic necropolis were investigated also using measurement of the density of the finds and according to this value chemical composition of the base elements was evaluated (gold, silver and copper) (see [Бояджиев, 2009]). At the same time some technological aspects for the production of gold finds were proposed [Бояджиев, 2009].

Several generalizing publications appeared in the last years concerning the searching and exploitation of gold bearing river sediments and ores on the territory of Bulgaria (see e.g. [Авдеев, 2005; Милев и др., 2007]). A range of specialized studies from the point of view of the geology of gold ores finds on the territory of Bulgaria (see e.g. [Ковачев и др., 2007; Mladenov et al., 2007]) and of Romania [Cojocartu et al., 2003] should be also added to this. However none of these studies deals with especially identifying of specific gold sources used in ancient times.

The above short review of the studies status shows that a close examination of the Varna necropolis gold finds is practically missing. The analyses available are partial and the methods used are not able to solve in a modern way the basic question – what are the origins of the most ancient treated gold in the world? (see [Бояджиев, 2009; Hartmann, 1978]).

There is literature with information about the geological gold bearing regions, presenting interest for today's industrial gold extraction. However this information has not been gathered so that a comparative study with gold archaeological finds would be feasible and therefore it is practically difficult for use in determining the Varna necropolis gold origins.

**PRINCIPLE FOR GOLD ORIGIN DETERMINATION**

For archaeological gold origin determination there is a two-step procedure:

a) determination of chemical composition of native gold samples, recovered from gold-bearing regions;

b) chemical composition determination of the investigated archaeological finds.

In Table 1 a list of chemical elements which could be used as indicators is presented. According to the presence/absence and/or quantity of these elements it is possible to determine geochemical (geographical) region of native gold sources.

On the basis of the data obtained from chemical analysis of the gold finds it is possible to reach some conclusions about the origin of the gold, i.e. if it was recovered from primary or secondary deposits. In principle, only by similarity (or differences) in chemical composition of native gold and the gold of archaeological objects, it is difficult to determine the *exact mining place* of gold. But on the basis of chemical composition of archaeological gold finds and native gold samples it is possible to determine *geographical region* (geochemical regions) where the gold was recovered.

In principle concentration of silver in prehistoric objects from Europe is in the range from 4 to 45%. The peak of the distribution of concentrations is around 12 – 14% of silver. The concentration of copper is between 0.5% and 15%, and from the trace elements only the tin could be found in high concentrations. The peak in tin concentrations in the gold finds is around 0.1% but it could reach even 1%! The determination of tin in the finds of gold is accepted as evidence that the gold used for production of these objects was recovered from panning river sediments, i.e. they were produced using gold from secondary deposits.

Platinum is one of the most important trace elements in gold. The concentrations of platinum in gold are in the interval from 0.008 to 0.03%. At the same time in archaeological finds of gold found in Europe the content of lead up to 0.3% was determined; of zinc – up to 0.3%; of antimony – up to 0.2%; of arsenic – up to 0.03%, of bismuth – up to 0.07%; of nickel – up to 0.04%; of tellurium – up to 0.05%, as well as some traces of iron.

In literature it is accepted that concentration of copper higher than 3% is an evidence of intentional adding of copper to the gold, i.e. artificial alloy. At the same time if the content of silver in archaeological finds is very low this could be accepted as evidence that the silver was extracted from the gold technologically using a method which we call "cementation", i.e. this is an evidence of artificial purification.

Thus to carry out the archaeometric investigation of the gold finds from Varna Chalcolithic necropolis and to obtain the answer to the question – ***Where was the gold used for production of the gold objects recovered?*** It is necessarily to determine:

- chemical composition of the archaeological finds of gold;
- chemical composition of the native gold recovered from different gold-bearing river sediments;
- mineral content of the geological samples gathered from the gold-bearing regions.

**WORK PROGRAM DESCRIPTION**

Evaluation of the sources of gold used for preparation of archaeological gold finds from the Chalcolithic necropolis of Varna will be carried out through the following activities:

I. Geological survey of the region of Burgas, Malko Turnovo, East Rhodope, Stara Zagora, and the region of Varna (the valley of Kamchiya river);

II. Study of the chemical and mineralogical composition of the river sediments. Determination of the morphology and chemical composition of the gold from geological samples;

III. Determination of chemical content of archaeological gold finds using Energy Dispersive X-Ray Fluorescent analysis (hand-held ED-XRF) for determination of the mean components– gold, silver and copper in archaeological finds of the necropolis of Varna. Sampling of archaeological finds from the necropolis of Varna and determination of microelement content of archaeological gold finds and gold of geological samples using LA-ICP-MS, as well as ICP-MS of dissolved samples – see the list of elements in Table 1.

IV. Statistical evaluation of the obtained analytical data cluster analysis, discriminant analysis, analysis of the mean components.

**CONCLUSION**

The main result of the proposed investigation is the determination of the places of recovery of gold used for production of Varna gold finds. Discovering these sources of gold will result in a

**Table 1.** Chemical element-indicators for localization of archaeological finds produced from gold according to the chemical composition of the gold from the gold deposition and the technology of production.

| Origin | Origin and/or technology of production | Technology of production |
|---|---|---|
| Ag, As, Cu, Ir, Os, Pb, Pd, Pt, Ru, Sn, Te | Bi, Cd, Fe, Ni, Pb, Sn, Te, Zn | Ag, Cu, Hg |

new approach for our understanding of the development of the first metallurgical centre not only on the Balkans but also in Europe. Obtained results will help in understanding of the social structure of the first society which accumulated such an impressive quantity of gold.

Parallel to the result of understanding the social organization and the material supply of this oldest human civilization that used large quantities of gold as hierarchical maker, the data from this investigation will be helpful for the gold deposits genesis in Bulgaria.

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# BULGARIAN ADDED VALUE TO ERA

## SUSTAINABLE DEVELOPMENT OF THE JOINT GENOME CENTRE

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### INTRODUCTION

In 2000, plant genomics was recognized as a key priority at the famous EC-supported Versailles Conference - Agricultural Research in European Research Area (ERA). In this field of research EC has a serious concern of lagging behind not only from USA, but also from China, Japan and even Brazil where important programs on plant genomics are being developed at an unprecedented scale. In Europe several countries have started organizing plant genome research. France, Germany and UK with Genoplante, GABI and GARNET have ongoing national programmes. Netherlands, Sweden, Spain and Italy are currently also building national programmes. Based on these considerations, a further development of ERA-NET on plant genome research in EC has been envisaged. Three main areas will be covered by the programme: (i) structural genomics; (ii) functional genomics and (iii) genomics-based analysis of biodiversity.

Genomics is one of the fifth national priority programmes launched by the Bulgarian Government in 2001. In recent years a number of research units in Bulgaria (e.g. the AgroBioInstitute at Agricultural Academy, the Institute of Molecular Biology within the Bulgarian Academy of Sciences, the Faculty of Biology at Sofia University "St. Kl. Ohridski", the Genetics Department of the Medical Academy, and LB Ltd.) established relatively good facilities and they have human potential necessary to conduct high-tech research in the field of human, plant, animal and microorganism genomics. In spite of the achieved results, there is a significant delay in the development of scientific and technological capacity for providing an intensive genome research in Bulgaria. Bulgaria is far behind the EC countries, as well as a number of developing countries. The neglecting of key fields like genomics, proteomics, metabolomics and bioinformatics will have a long-term negative impact on the development of a number of applied science fields. These include predictive and preventive diagnostics in human and animal health care, selection of new and more effective plant varieties and animal breeds, characterization and use of genetic resources for food, pharmaceutical, industrial and environmental purposes. The main factors which hampered the development of genome research in Bulgaria are: (i) insufficient budget financing; (ii) fragmented research and technological potential; (iii) lack of industry interest; (iv) lack of modern infrastructure and equipment; (v) lack of international cooperation.

In 2007 and 2008 the National Science Fund in Bulgaria (NSF) opened calls for infrastructural projects "Development of the Research Infrastructure". It was an extremely timely initiative to start-up and to develop specialized research infrastructures where consortia of different institutions carry out high level and competitive science, training and diagnostic activities. The following two projects submitted by the AgroBioInstitute have been funded by the NSF within the above call:

1. Joint Genome Center (JGC), Contract: ИФС-Б-604; Call: Establishment and development of infrastructure; 2008 – 2009; Project leader: Prof. Atanas Atanassov; Partners: Faculty of Biology, Sofia University "St. Kl. Ohridski" and Institute of Genetics, Bulgarian Academy of Sciences.

2. Center for sustainable development of plant and animal genomics; Contract No ДО02-105; 2009 – 2012; Project leader: Prof. Atanas Atanassov.

**Module 1:** Sustainable development Joint Genome Centre (JGC SusDev); Partners: Faculty of Biology Sofia University "St. Kl. Ohridski" and Institute of Genetics, Bulgarian Academy of Sciences.

**Module 2:** Centre for sustainable development of plant genomics; ABI is a single applicant of the project module.

**ESTABLISHMENT OF JOINT GENOMIC CENTER (JGC)**

Based on the current situation and problems related to the organization and realization of genomics, proteomics, metabolomics and bioinformatics research in Bulgaria it could be concluded that a substantial part of the pointed above negative tendencies could be overcome by the establishment of the Joint Genomic Centre (JGC). The development of the adequate infrastructure for such JGC starts with the implementation of the NSF project 'Joint Genome Center (JGC)', Contract: ИФС-Б-604. The JGC currently incorporates qualified teams from the AgroBioInstitute and some departments of Faculty of Biology, Sofia University "St. Kliment Ohridski" and of Institute of Genetics (BAS). The consortium includes well recognized researchers, lecturers and young and highly motivated scientists (post docs, PhD students and students (bachelors and masters degree programs)) from three leading Bulgarian research organizations in the field of life sciences. According to the NSF infrastructural project conditions, the main part of the funding (up to 80%) is allocated to acquiring of specialized equipment. The aim of the Joint Genome Center project is to initiate the establishment of research infrastructure for applied research, diagnostics and training, in the field of genomics for assessment and stock-taking of nationally important biological resources.

**CENTER FOR SUSTAINABLE DEVELOPMENT OF PLANT AND ANIMAL GENOMICS**

The main goal of the second NSF funded project 'Center for sustainable development of plant and animal genomics' Contract: ДО0-105 (with its two modules) is to establish Centre for sustainable development of plant and animal genomics aiming to support the Bulgarian bioeconomy by strengthening the research capacity of the AgroBioInstitute (Centre of Excellence in Plant Biotech, as recognized by the EC in 1999) as the leading institute in Bulgaria in the field of agro- biotechnology. High value theoretical and practical results based on the utilization of the national biodiversity and the development of new competitive products for the agriculture, pharmaceutical and food industries are expected to be raised. The work program of the project includes several key activities: (i) upgrade of the research infrastructure of the AgroBioInstitute; (ii) exchange visits in leading European research centres; (iii) initiation of several key research projects; (iv) dissemination, education and training activities; (v) technology transfer and preservation of intellectual property rights.

**UPGRAIDING OF THE RESEARCH INFRASTRUCTURE AND EQUIPMENT FOR SYSTEMS BIOLOGY TRAINING, RESEARCH AND DIAGNOSTIC ACTIVITIES**

During the two NSF funded projects 'Joint Genome Centre' and 'Centre For Sustainable Development of Plant and Animal Genomics' and a separate collaborative contract between ABI and the National Agency of Fisheries and Aquaculture (NAFA) several specialized apparatus and equipment have been acquired or are in the process of acquiring through a public tender:

**Real-time PCR system – Applied Biosystems 7300**. The system was acquired through a collaborative contract between NAFA and ABI where NAFA is the beneficent of a PHARE funded project and ABI is the recipient of the acquired equipment. The real-time PCR system is a versatile machine with a number of applications: (1) estimation of the level of expression of genes of interest; (2) determination of gene copy number in the genome of organisms as well as the copy number of transgenes in GMOs; (3) detection of SNP markers.

**Variable Mode Imager Typhoon Trio+** Variable Mode Imager (GE Healthcare) - The system was acquired through a collaborative contract between NAFA and ABI where NAFA is the beneficent of a PHARE funded project and ABI is the recipient of the acquired equipment. The Typhoon Trio+ Variable Mode Imager is highly sophisticated equipment with a large scale of diverse applications. The system will be used for detection of fluorescent and chemiluminescent signals from gels (directly through the electrophoresis glass plates by using low fluorescent glasses) and membranes. Due to its high resolution the imager is also capable of reading microarrays. It allows ABI to apply the microarray technology and to simultaneously analyze the expression of hundreds and thousands of genes.

**Microarray hybridization oven** (Agilent technologies). The microarray hybridization oven complements well with the Typhoon Trio+ Variable Mode Imager which is capable of reading microarrays (Acquired through NSF project ДО0-105).

**Manual microarray spotter** (GE Healthcare) – the manual microarray spotter allows the manual creation of microarray slides with 768 spots for hybridization per slide. Thus at present ABI has full capacity to carry out *in house* small to medium scale microarray gene expression analysis sufficient for the present state of the national bio-sciences (Acquired through NSF project ДО0-105).

**Photodocumentation system** - EC3 300, UVP. The system allows documentation of signals from electrophoresis gels and hybridization membranes. (Acquired through NSF project ДО0-105).

**Ultra low temperature horizontal deep freezer (-80°C)**, Sanyo – The deep freezer will allow to satisfy the needs of the constantly growing work at ABI requiring long-term storage of plant and other material at ultra low temperatures (Acquired through NSF project ДО0-105).

**System for automatic purification of DNA and RNA** – Qiacube, Qiagen GmbH. The system allows full automation of the process of DNA and RNA purification from bacterial, plant and animal tissues (Acquired through NSF project ДО0-105).

**Laboratory mill** - TissueLyser II System, Qiagen GmbH. The acquired laboratory mill allows simultaneous grinding to a fine powder of up to 96 samples at ultra low (liquid nitrogen) or room temperatures (Acquired through NSF project ДО0-105).

**Spectrophotometer for analysis of samples in small volumes (1µl)** - Nanodrop 2000, Fisher Scientific UK (Acquired through NSF project ДО0-105).

**System for capillary agarose electrophoresis** and fragment analyses of non-labelled PCR products for mapping purposes QIAxcel, Qiagen GmbH. The system is capable of fully automated electrophoresis of samples from a 96 PCR plate, which makes it suitable for genotyping of segregating populations and genetic resources collections. Main advantage is the use of non-labelled PCR primers (Acquired through NSF project ИФС-Б-604).

**Centrifuge with ability to handle microplates – Sigma** – The centrifuge is suitable for simultaneous centrifugation of several PCR plates, which complements it well with the system for capillary agarose electrophoresis, the PCR machines, etc. (Acquired through NSF project ИФС-Б-604).

**A set of multichannel pipettes** for simultaneous pipetting of 8 samples. The ability to simultaneously pipette eight samples allows quick handling of samples and sample preparation for PCR plate, DNA purification, etc. (Acquired through NSF project ИФС-Б-604).

**Laboratory centrifuges** Sigma 1-15PK, Sigma 1-14 – Although basic equipment the centrifuges are absolutely necessary for almost all molecular biology applications (Acquired through NSF project ДО0-105).

**Single quadrupole GC/MS system Agilent technologies 7890A/5975C,** equipped with autosampler, module for headspace analysis, software for automatic deconvolution of the mass spectra and software for rapid discovery of protein and metabolite biomarkers GeneSpring MS 1.2.

The GC/MS system is mainly used for non-target metabolite analysis (metabolite profiling) of segregating populations and genetic re-

sources collections (Acquired through NSF project ИФС-Б-604).

**Rotation Vacuum concentrator** - public tender is in progress. The vacuum concentrator will find its main application in the process of sample preparation for the GC/MS system (NSF project ДО0-105).

**Laboratory lyophilizer** - Alpha 1-2 LDplus, Martin Christ GmbH – The laboratory lyophilizer will be used for both sample preparation for the GC/MS system and for lyophilization and long-term storage of plant samples at room temperature (Acquired through NSF project ДО0-105).

**Thermomixer** - Tmix, Analytik Jena AG. The thermomixer will be used mainly for sample preparation for the GC/MS system (Acquired through NSF project ДО0-105).

**Laboratory hoods** – the laboratory hoods will find their main application for support of the metabolomics research and especially for the work with toxic organic solvents applied in the sample preparation for GC/MS analysis (Acquired through NSF project ДО0-105).

**System for pure and ultra pure water** - Purelab Option S7, Purelab Classic UVF (Acquired through NSF project ДО0-105).

**Dewars** – Air Liquide (Acquired through NSF project ДО0-105).

**Automatic DNA sequencer** – public tender is in progress. The automatic 4 capillary sequencer will be suitable for both precise sequencing of long DNA fragments and for fragment analysis (SSR, AFLP, SNP, RAPD, etc.) (NSF project ДО0-105).

**Four PCR machines –** public tender is in progress. The four machines will meet the constantly growing demand for application of PCR based techniques (NSF project ДО0-105).

**Fluorescent microscope** with digital camera and advanced image processing software – public tender is in progress. The apparatus is expected to respond well to the growing demands for advanced fluorescent microscopy related to GFP live imaging and FISH research (NSF project ДО0-105).

**ADMISSION TO BENEFIT/OPERATE BY OTHER UNIVERSITIES AND RESEARCH ORGANIZATIONS**

System biology approach (i.e.'omics technologies) are related to many other areas of industry, which determines a large scale stakeholders to use high tech equipment of the new infrastructure. The access to the equipment acquired by the project funding will be granted on a project basis as well as a service. Access to the equipment will also be granted to students who follow educational programs of the Biology faculty of Sofia University "St. Kliment Ohridski".

Advantage for using the equipment will be given to the members of the Consortium which developed the proposed project. They will be able to use the equipment by providing their own qualified personnel, the necessary reagents and consumables for the analysis. Access to the equipment of the JGC will also be given to other universities, research institutions, companies, laboratories and private representatives on the basis of the principles underlying the establishment of the JGC, namely the establishment and functioning of consortiums in a research field of common interest for the members of the consortium, which will apply for private or governmental funding following research programs in Bulgaria, EU and the rest of the world. The consortiums will function in the frame of the JGC and will use its equipment until there is funding for the projects won by the respective consortium.

**MID–TERM PLAN FOR THE USE OF EQUIPMENT AND EVALUATION FOR ITS IMPLEMENTATION IN RESEARCH, EDUCATION AND DIAGNOSTIC AREA**

Recently most of the ABI research is focussed on application of contemporary molecular genetics methods. Many of the current projects are related to genotyping of economically important crops including wheat, barley, maize, sunflower, grape, small berries, *Rosa damascena*, etc. Development of a molecular marker genetic map of grape and mapping of markers linked to important quality traits and disease resistance is in progress.

The following research projects from the research agenda of AgroBioInstitute are in progress as part of the NSF: ДО0-105 project: (1) Crops with increased drought resistance; (2) *Haberlea rhodopensis* a model plant to understand water stress deficiency; (3) Pyramiding fungal pathogen resistance genes in elite wheat

cultivars; (4) Development of sunflower lines with improved tolerance to fungal diseases. Mapping of QTLs for disease resistance in sunflower lines derived from interspecies hybrids; (5) Towards development of new grapevine lines with improved agronomical characteristics; (6) Development of new oil bearing rose lines with improved agronomic characteristics; (7) Development of legumes genomics in Bulgaria; (8) Metabolomics of Bulgarian grape and wine and (9) Metabolomic quantification and biodiversity description of small berries fruits.


**Fig. 1.** System for cappilary agarose electrophoresis QIAxcel


**Fig. 2.** System, including Gas chromatograph Agilent 7890A and mass-selective detector Agilent 5975C

# REPRODUCTION RESEARCH CENTER (RRC)

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In June 2008 the Institute of Biology and Immunology of Reproduction, Bulgarian Academy of Sciences (IBIR-BAS) in collaboration with the Center for Reproductive Health, Medical University Pleven and Institute of Reproductive Health, Sofia, formed a consortium to prepare a project to be submitted in the Competition "Development of the scientific infrastructure-2008" announced by the Ministry of Education and Science. The project is entitled **"Establishment of Center for research on problems of the reproductive health"** and its major aim is to create a research center equipped with modern sophisticated apparatuses and machines where to conduct high technology research on the problems of reproduction with a significant impact on national and European level.

The rationale for the establishment of such a research center is based on the increasing percentages of infertile couples, recurrent abortions and general increase of numbers of patients with reproductive problems. Well established tendency is young women to postpone their decision to have a baby for later years of their lives and then come the problems with infertility. All these problems put forward the need for an advanced research reproductive center which is to support the efforts of all clinics and centers for advanced reproductive technologies (ART) in Bulgaria.

Problems of the reproductive health are considered of great importance for the demographic crisis in Bulgaria and in Europe as a whole. Statistical data clearly outline the tendency of decreased birth rate and an increase of cases with infertility. It is presumed that infertility rate will progress steeply in the next decade and the ratios of infertile to fertile couples are expected to change from 1:7 to reach 1:3. Currently the infertility rate is estimated to be 15% of the couples and the causes of infertility are both in females and males. Although it is still considered that the female factor is the major reason for infertility, it has been demonstrated that at least in 30% of the infertile couples the male factor is the cause. At least one half of the male infertility is due to abnormal spermatogenesis leading to production of spermatozoa with pathological forms.

Disturbances of the normal reproduction are still other causes of the decreasing of the birth rate and the most common event is the spontaneous recurrent abortion, which is the end point of the pregnancy failure or the repeated implantation failure after transfer of viable embryos in ART. This process is known to be due to disturbed balance of hormones, cytokines, growth factors, immune factors and other still unknown factors and mechanisms.

These data proves that systemic and detailed studies are needed in the field of the reproductive biology, which can be carried out with the joint efforts of a multidisciplinary research team. That is the reason to include in the project team specialists from different fields of biological sciences such as biologists, medical doctors, veterinary doctors, zooengineers, chemists from the Institute of Biology and Immunology of Reproduction (Bulgarian Academy of Sciences), Medical University Pleven and non-governmental non-profit scientific organization (Institute of Reproductive Health).

The organized Consortium enlists well-known specialists both in our country and abroad in the field of reproductive biology and immunology, as well as young researchers and PhD students who are well qualified in high-technology and innovative methods and techniques, such as iso-

lation and characterization of human adult stem cells, proteome analysis, structural and functional analysis using confocal microscopy. All these equipment, methods and techniques will be applied to do research on problems of the reproductive health in humans.

The Reproduction Research Center (RRC) is situated on the territory of the Institute of Biology and Immunology of Reproduction, which is the founder of the scientific problem "biology and immunology of reproduction" in Bulgaria and the founder of the scientific branch "reproductive immunology" in the world science. The RRC has a core laboratory equipped with flow cytometer, real-time PCR machine, sperm analyzer (Cassa system) HPLC system, 2-D electrophoresis for proteomics with scan reader, sophisticated microscope and inverted microscope, CO2 incubators and safety cabinets, confocal microscope.

Core laboratories of the RRC are open for collaboration between different research units in the Bulgarian Academy of Sciences, Medical Universities, Sofia University "St. Kl. Ohridski" with the aim to contribute to building up an efficient research potential in the Bulgarian research community.

The RRC will conduct research according to the program which has been approved by the Ministry of Education and Science and is directed in the following directions defined as specific research tasks. Each research task is to be worked out by a research unit headed by a senior researcher and consisting of young PhD students and post-doc researchers.

**The first task is devoted to "Isolation and characterization of proteins involved in the reproductive process" (M. Stamenova)**. The aim of this set of experiments is: i) to obtain maximally purified proteins from various organs, tissues, cells and biological fluids involved in the process of reproduction; ii) to evaluate changes of their characteristics in pathological conditions; iii) to explore possibilities to apply newly gained knowledge for development of new means for diagnosis and prognosis of reproductive pathologies.

**Chromatographic methods are applied for isolation and purification** of proteins from spermatozoa and reproductive tissues of the male reproductive system; proteins from germinal and somatic cells, components of the female reproductive system; proteins from lysates of cell cultures or blood serum.

**The physicochemical and immunochemical characteristics of purified proteins are carried out by** SSDS-PAGE and isoelectrofocussing are used to determine some very important parameters of the newly identified molecules (molecular mass and isoelectric point).

Immunoenzyme assays and immunoblot are used to determine the antigenic specificity of the molecules isolated from reproductive tissues and organs.

**Studies on the localization of the newly identified antigens are carried out using** immunoperoxidase and immunofluorescent techniques to determine the localization of the antigens under study in reproductive and/or somatic tissues and cells.

**Proteomics analysis by** 2-D electrophoresis and subsequent analysis using specific software products is applied for proteomics analysis of changes in molecules with high impact in the reproductive process under normal physiologic conditions or under pathological conditions of the reproductive process.

**The second task is to perform studies on the stem cells in human reproductive system (S. Kyurkchiev)**

Studies are currently carried out on the presence and characterization of human stem cells in the male and female reproductive systems. Previous studies in our laboratory have demonstrated the presence of mesenchymal stem cells in human endometrium and early decidua, which are characterized by their capacity to proliferate, to differentiate in osteogenic, adipogenic endothelial and decidual cells. These studies are spread to include other parts of the male and female reproductive systems such as testis, ovary, prostate.

**Biopsy samples form human testis** are to be supplied to the laboratory within 2 hours after collection and will be processed following specific laboratory protocol as published for isolation of spermatogoonal stem cells (SSC). Isolated cells are cultured in the presence of recommended growth factors and cytokines and

characterized in regard to their capacity to proliferate and to undergo the next stages of spermatogenesis. Commercially available reagents and antibodies as well as antibodies produced in our institute are applied for detection of unique stage-specific products by immunoblot confocal immunofluorescence, flow cytometry, RT-PCR and other informative methods.

**Experiments to induce the transdifferentiation of human mesenchymal stem cells** (hMSC) isolated from human bone marrow into spermatogoonal cells are performed. Briefly, the hMSC are isolated from bone marrow samples delivered to the lab for processing and culturing in the presence of specific inducing factors and hormones.

**Isolation and characterization of human adult stem cells isolated from human ovary after** ovary biopsy samples and/or cells suspensions collected during ovary puncture for the purposes of the IVF procedure are grown in the presence of growth factors and cytokines in attempt to isolate, grow and characterize ovary stem cells. Special experimental designs are prepared to test the capacity of these cells to secrete reproductive steroid hormones and to form structures similar to ovarian follicles.

The equipment needed for performing the studies outlined above includes $CO_2$ incubator, laminar flow box, bench centrifuge, inverted phase-contrast microscope with camera, fluorescent microscope with camera, PCR machine, plasticware, specific culture media and sera, growth factors, hormones and cytokines, fine reagents and chemicals.

**The next task is objective quantitative and qualitative analysis of human spermatozoa (M. Mollova)** which is performed of the conventional and functional parameters of spermatozoa from normozoospermic or oligo-astheno-teratozoospermic infertile men to help the selection of the optimal way of treatment and prognosis of the outcome after treatment with in vitro fertilization in the clinical practice.

**Computer-assisted analysis of the standard parameters of sperm samples in regard to concentration, motility and morphology and their assessment and classification** is carried out on sperm samples from normozoospermic oligo-astheno-teratozoospermic infertile men using the automatic system **Sperm Class Analyzer** as the following parameters will be assessed: concentration in ml. and the whole volume; total count of immotile (type D) and motile (types A,B,C) spermatozoa; the curvilinear, rectilinear and mean velocity of the spermatozoa; index of linearity; index of oscillation, head lateral amplitude; frequency of the wave stroke. Analysis of the sperm morphology: dimensions, length and form of the head and acrosome; defects in the sperm mid-piece and tail is performed.

**Objective analysis of the functional parameters of sperm** samples from normozoospermic oligo-astheno-teratozoospermic infertile men is done in regard to the capacity of the spermatozoa to be hyperactivated and capacitated as assessed by computer-assisted analysis of the curvilinear, rectilinear and mean velocity of the spermatozoa; index of linearity; index of oscillation, head lateral amplitude; frequency of the wave stroke; evaluation of the acrosome status, spontaneous and/or induced by Calcium Ionophore A23187 acrosome reaction including computer-assisted determination of the hyperactivated/capacitated status of spermatozoa; analysis of the acrosome status of the spermatozoa after staining with fluorescein-labelled *Pissum sativum* agglutinin; assessment of the spontaneous or induced with Calcium Ionophore A23187 acrosome reaction with subsequent application of ARIC test.

**Analysis of the DNA integrity of spermatozoa by SCD (Sperm chromatin dispersion test) by the application of the Halosperm DNA Fragmention kit** is done of spermatozoa from normozoospermic or oligo-astheno-teratozoospermic men by SCD (Sperm chromatin dispersion test) (Fernandes et al., 2005) using the Halosperm DNA Fragmention kit. The sperm cells are treated following the protocol recommended by the producer company and stained for microscopic reading. The DNA fragmentation is visualized by forming a "hallo" as a result of the chromatin diffusion around the sperm head.

*In situ*-nick translation DNA analysis is done using Halosperm DNA Fragmention kit which permits classification according to the morphol-

ogy of the nucleotides after the protein digestion and chromatin diffusion in the nuclei containing fragmented DNA.

**The fourth task is to study the mechanisms of ovarian infertility (M. Ivanova)**. The aim of this research is to determine the role of antibodies against hormones and anti-ovarian autoantibodies as causative agents for infertility in women.

**Detection of anti-ovarian and anti-hormone antibodies in infertile women by immunoenzyme assays using** sera from women with POF (premature ovarian failure)/ POI (premature ovarian insufficience) and/or infertile women are tested to define more accurately the autoimmune etiology and diagnosis.

Serum samples and follicular fluid samples from women enlisted in programs for assisted reproduction are tested and analysis of the correlations of the presence and prevalence of antibodies with the outcome of the hormonal stimulation and IVF/ET is made. Analysis of the frequency of antibodies against hormones and ovarian antigens in the studied patients groups is carried out.

**Tissue and cellular localization of specific ovarian antigens is determined by immunohistochemical techniques**. Western blotting analysis is done of the target proteins in ovarian extracts (from different types of cells) using patients sera. Immunohisto- and immunocytochemical localization of the target proteins which have induced the antibodies present in patients sera is performed.

**Assessment of the levels of cytokines, apoptosis and autoreactivity against the ovarian antigens** is carried out on the correlations of the cytokine levels (Th1/Th2) and anti-ovarian antibodies in the follicular fluid with the apoptosis of granulose luteal cells from women enlisted in IVF/ET programs. The apoptosis levels are evaluated of granulose luteal cells by DNA-DAPI staining and TUNEL assay. Assessment of the cytokines levels is done by specific kits in follicular fluid samples from women enlisted in the IVF/ET program. All data obtained are analyzed and correlated to the outcome of assisted reproductive treatment of the patients.

**The fifth task is to use flow cytometry analysis of the platelet activation status and platelet–leukocyte aggregates in women with reproductive failures (E. Konova)**. By flow cytometry of the activation status of platelets and the levels of platelet-leukocyte aggregates (PLA) in women with reproductive failures (two or more spontaneous abortions, still births, two or more unsuccessful IVF attempts) and pregnancy complications (fetus retardation, preeclampsia) are assessed.

Constellation is evaluated of the platelet activation status and PLA with the presence of congenital and/or acquired factors for thrombophilia in women with reproductive failures. The functional status is compared of the platelets and PLA in women with reproductive failures and control group of healthy women. Participation of the platelet activation and PLA in the pathogenesis of the reproductive failures and their significance for prognosis of pregnancy outcome is assessed.

Flow cytometry is used to monitor the anticoagulant and anti-aggregate therapy in women with infertility on the basis of the platelet activation status and PLA presence.

The activity of the Reproduction Research Center is managed by:

**Project coordinator** is Associate Professor Margarita Mollova, MS, PhD, Institute of Biology and Immunology of Reproduction "Acad. K. Bratanov", Bulgarian Academy of Sciences (IBIR).

**Members of the Consortium:**

Associate Professor Emiliana Konova, MD, PhD, Center for Reproductive Health, Medical University Pleven;

Professor Stanimir Kyurkchiev, MD, DSc, Institute of Reproductive Health, Sofia.

## MADE IN BULGARIA WITH EUROPEAN SUPPORT

# LOW-BUDGET X-BAND MICROWAVE RADIOMETER FOR REMOTE SENSING INVESTIGATIONS

**Boris Vichev, Kosta Kostov**
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72, Tsarigradsko shosse Blvd., 1784 Sofia, Bulgaria

During the last decade in the Institute of Electronics, Bulgarian Academy of Sciences (IE-BAS) several low-budget microwave radiometers for C- and Ku-bands have been developed using commercially available components for satellite TV receivers. Our research team was the first to start investigations in this field in 1997. This research was motivated by the need to decrease the radiometer cost and to make them more affordable for researchers in the developing countries. The results from laboratory and field experiments in Bulgaria and Vietnam confirmed that these radiometers are suitable for investigations of natural objects in well-controlled conditions. Their general advantage over conventional radiometers is their low cost combined with good technical parameters. Recently the idea of low-budget radiometers has been developed by other authors.

During the period of 2008-09 an X-band modulation (Dicke-type) radiometer type XRM was developed using components from satellite receivers in the framework of the Bulgarian-Vietnamese government program for cooperation in science and technology under the research project "Design and development of a Dicke-type microwave X-band radiometer and its utilization for environmental investigations", concluded between the IE-BAS and the Institute of Space Technology, Vietnamese Academy of Science and Technology, Hanoi.

The developed radiometer is a highly sensitive microwave receiver of the noise emission from different natural objects. It consists of two parts, a Microwave unit (Receiver block) and an Info-unit. A pyramidal horn antenna on the input of the radiometer is directed toward the object under investigation. The radiometer front end in the Microwave unit comprises conventional X-band waveguide components. The down-conversion of the modulated signal is realized using components for satellite TV receivers: Ku-band low-noise block-converter (Noise figure 0.5 dB) and a tuner (Frequency bandwidth 30 MHz). Special attention is paid to decreasing the radio-frequency interference effects using a band-pass filter and tuning of the radiometer center frequency. Special electronic circuits are developed for processing of the law-frequency signal, proportional to the brightness temperature of the object. The main block of the Info unit is a microcontroller. Special software is developed for data acquisition and processing, and different commands generation according to the selected mode of operation.

The temperature regime of the microwave unit is realized using the common thermo-stabilizer, which maintains constant temperature of about 50°C. In addition a second thermo-stabilizer is implemented for maintaining the temperature of the reference temperature component close to 55°C independently from the variations of temperature regime inside the microwave unit. The temperature regime proposed improves the short-term and long-term radiometer stability.

The main parameters of the XRM are given in Table 1.

General view of the XRM radiometer is shown in Figure 1.

The measured radiometer resolution meets the requirements for remote sensing and monitoring of natural objects and ecosystems.

The radiometer XRM is the final result of our long-term research efforts for designing and developing low-budget radiometers using components for satellite receivers. Experiments for remote sensing of soil moisture, vegetation and sea surface will be carried out in Vietnam in the autumn of 2009.

| | |
|---|---|
| • Type: | Dicke-type radiometer |
| • Center frequency: 10.90 ... 11.15 GHz | (8 preselected fixed positions) |
| • Frequency bandwidth: | 30 MHz |
| • Resolution: | ≤ 0.2 K |
| • Integration time: | 1 s |
| • Short-term instability | ≤ 0.2 K |
| • Input range: | 0–320 K |
| • Antenna beamwidth | 17° |

**Table 1.** Main parameters of X-band Dicke-type radiometer XRM


**Fig. 1.**

# INNOVATION SOLUTION FOR INCREASING EFFICIENCY OF BIO–ETHANOL PRODUCTION FROM STARCH

**Maya Ignatova, Velislava Lyubenova**
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Acad. Georgi Bontchev Str., Blok 2, 1113 Sofia, Bulgaria

A new control strategy for bio-ethanol production from renewable source (starch) is proposed by a research team at ICSR-BAS. The proposed new methods and algorithms can be considered as a contribution to the development of Biotechnological Process Control Theory since they are general ones and verified for monitoring and control of a wide class of bioprocesses.

It is well known that ethanol is produced during the fermentation of strains *Saccharomyces cerevisiae* on main carbon source glucose. Bio-ethanol production from renewable sources requires pre-treatment of raw materials as long as the necessary glucose for ethanol fermentation is obtained. In case of starch as raw material, the pre-treatment is a process known as saccharification, and it is realized by enzyme reactions in a separate bioreactor. In the last years new, more effective strains were produced by genetic engineering. One of these is the recombinant strain *Saccharomyces cerevisiae YPB-G*. During its growth the strain is able to excrete enzymes necessary for the starch to ethanol transformation, and to produce simultaneously ethanol on glucose. Practical application of the strain allows both processes saccharification and fermentation, to be carried out in one and the same bioreactor only. In such a way, the bioethanol production becomes more economical. The experiments with similar installations show that their effective work requires simultaneous control of both processes using the criteria of the maximal production and minimal starch expense. As an object for control, the considered process is characterized by one input – the starch feed rate – and two outputs – the concentrations of starch and glucose in the reactor. The information from both outputs is used for design of two new software sensors for the unmeasured process kinetic parameters – glucose consumption rate and glucose production rate. Furthermore, an analytical procedure for software sensors tuning is proposed.

In Fig. 1 the batch (without control) process phase is considered. In Fig. 1a, the measurements received by both software sensors are shown. As it can be seen, at the beginning of the process the glucose consumption rate is bigger than the glucose production rate (Fig.1a, red line) and the glucose concentration in the reactor decreases very fast (Fig. 1b). After 20 hr of fermentation the reaction rates become approximately equal and a quasi-equilibrium state of glucose concentration in the reactor is observed (Fig. 1b). This natural physiological state of the culture is characterized by maximal rate of ethanol production as it is shown in Fig. 1c. For the achievement of maximal productivity of the installation this physiological state has to be maintained as long as possible. For this purpose a control marker is defined on the basis of the information received from both sensors. This marker automatically identifies the above physiological state and keeps it switching on and off the starch feeding. The algorithm is defined as indirect adaptive impulse control (IAIC).

In Fig. 2, simulation investigations of the proposed IAIC are shown. The control is switched on automatically after the 50th hour (Fig. 2c) when the glucose production rate becomes lower than the glucose consumption rate. Applying this control, the duration of glucose concentration equilibrium state becomes three times longer in comparison with those in the batch phase (Fig. 2b). This effect leads to considerable increasing of the ethanol concentration at the end of the process (Fig. 2d). At the same time, the raw material the starch is consumed economically (Fig. 2a).

The proposed control strategy is planned to be experimentally verified on laboratory installation.

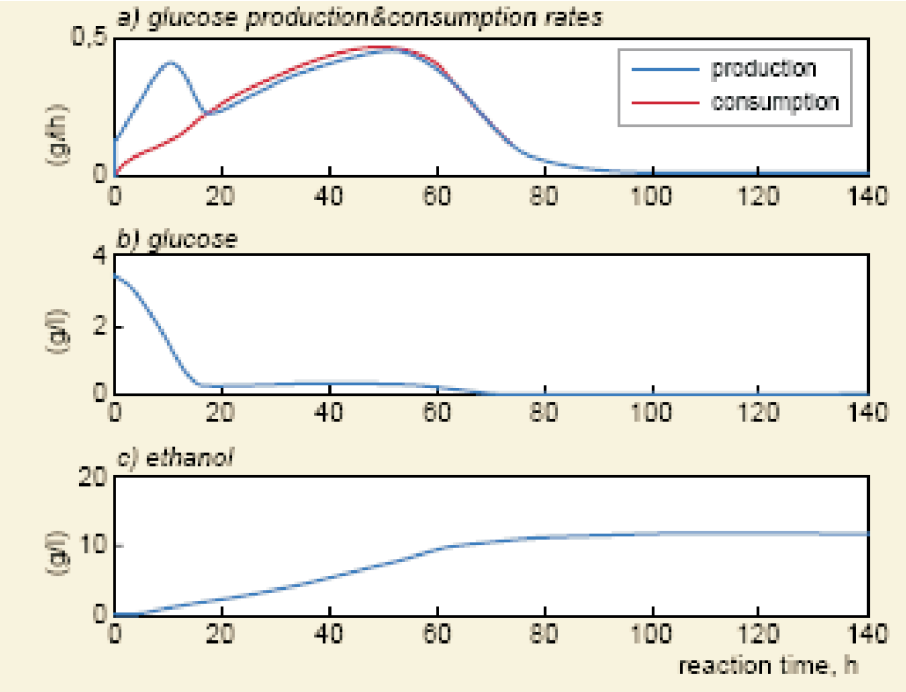


**Fig. 1.** Batch phase of the process and measurements received by software sensors

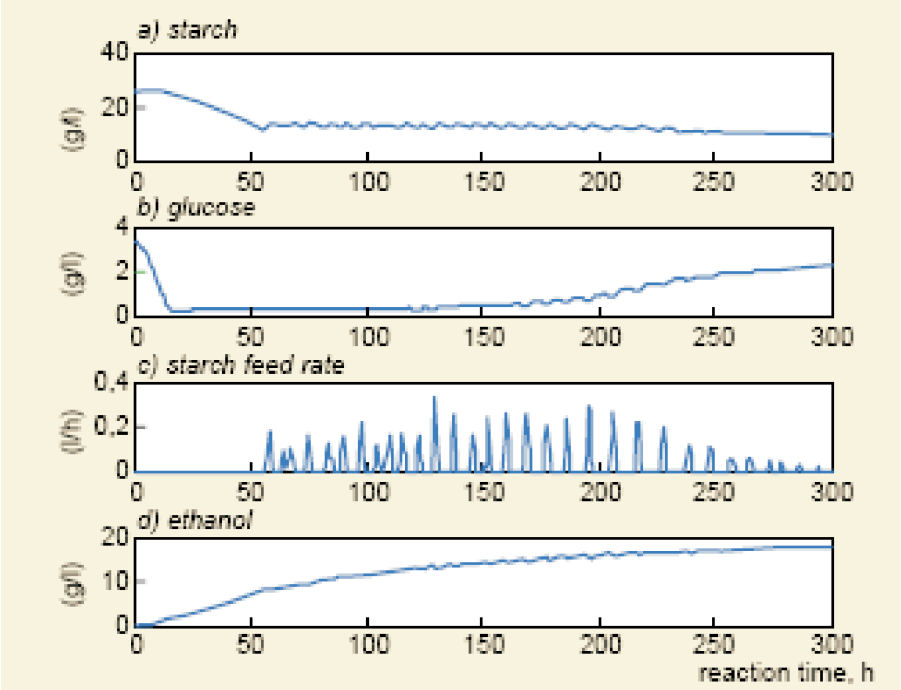


**Fig. 2.** Simulation investigations of the controlled process

# EQUAL IN EUROPEAN RESEARCH AREA

## BULGARIAN VIPs

**Assoc. Prof. NINA GOTCHEVA, MD, PhD**

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*Head of the Clinic of Cardiology and ICU of the National Heart Hospital, national consultant in cardiology and member of the board of governors of the International Society of Cardiovascular Pharmacotherapy.*

Assoc. Prof. Nina Gotcheva, MD, PhD was born on May 31, 1949 in Sofia, Bulgaria. Having graduated the English Language High School in Sofia in 1968, she went on to study medicine at Sofia Medical Academy, where she also had her postgraduate training in Internal Medicine. She was board-certified in Internal Medicine in 1981 and continued her specialization in Cardiology in *Hospital Broussais*, Paris, France. In 1985 she was board-certified in Cardiology and proceeded to specialize further in *Saitama Medical School*, Tokyo, Japan. She defended her PhD thesis on "Two-dimensional echocardiography for segmental wall motion evaluation" in 1990.

Assoc. Prof. Gotcheva began her professional experience as Assistant of Cardiology at the Cardiology Department of the National Centre for Cardiovascular Diseases in Sofia. In 1991 she was promoted to Associated Professor and appointed as Head of Cardiology Clinic B. Since 2001 she has been serving as Head of the Cardiology Clinic and Intensive Care Unit of the National Heart Hospital.

Since 1985 Assoc. Prof. Nina Gotcheva has been a member of the European Society of Cardiology, and serving on its Scientific Committee since 1994. She has also been actively involved in the Bulgarian Society of Cardiology, elected as General Secretary in 1992,member of the Scientific Committee in 1994, and editor-in-chief of the journal *Bulgarian Cardiology* in 1994. She is also an active member of the New York Academy of Sciences, fellow of ESC, board editor of the *Bulgarian Medicine Practice Journal*, member of TIMI Trialist Society, member of EAE. In 2006 she was appointed National Consultant in Cardiology by the Bulgarian Ministry of Health, and elected to the board of governors of the International Society of Cardiovascular Pharmacotherapy (ISCP). She has participated in several major ACS trials, namely SYMPHONY (as I and II, National Coordinator), EXTRACT-TIMI 25 (National Coordinator), FINESS (Co-Investigator) and ATLAS-TIMI 46 (National Coordinator).

**Assoc. Prof. STOYAN RUSSEV, PhD**
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*Head of the Department of Solid State Physics and Microelectronics, Faculty of Physics, Sofia University "St. Kl. Ohridski". Author and co-author of more than 50 papers in scientific journals and conference proceedings.*

Assoc. Prof. Dr. Stoyan Russev was born in 1958 in Lyubimetz, Bulgaria. He finished his secondary education in Lyubimetz in 1977. In 1983 he graduates in MSc degree in Physics, Sofia University "St. Kl. Ohridski". During 1983 - 1984 he is a physicist at the Laboratory of Applied Physics, BAS, Plovdiv. In 1985 he moved to the Department of Solid State Physics, Faculty of Physics at Sofia University "St. Kl. Ohridski", where in 1991 he presented his PhD thesis titled "Multiangle spectroscopic photometric ellipsometry set-up and applications". Up to 1992 he is an assistant professor at the Department of Solid State physics. In the period 1992 – 2000 he works as a senior assistant professor in the same department. Since 2000 he is an Associate Professor in solid state physics at Sofia University "St. Kl. Ohridski". Since 2007 he is the Head of the Department of Solid State Physics and Microelectronics.

During 1993 - 1994 he works with the group of Prof. Leblanc at the University of Trois-Riviere, Centre de Recherche Biophysique, Trois-Riviere, Canada, where his research is connected with analyses of inverse ellipsometric task and application of ellipsometry for the investigation of LB films. In 1995 he works in the field of ellipsometry under the supervision of Prof. Langevin at Centre de Recherche Paul Pascal, Bordeaux and Ecole Normale Superieure, Paris, France.

The main research field of Assoc. Prof. Russev is solid state physics, in particular application of ellipsometry for investigation of optical properties of materials, thin films and multilayered structures. His work includes also theoretical analyses of the forward and inverse ellipsometric tasks, using of electron microscopy and electron beam lithography and their applications in diverse fields like adsorption kinetics of proteins, sensors and multilayered structures. Apart of this, his work is connected with data acquisition and automation of the experiment. He is the Head of the Laboratory of ellipsometry and since 2007 – the Head of the newly established Laboratory "Technology of materials" – both in the Department of Solid State Physics and Microelectronics, Faculty of Physics.

He has been a coordinator or a member of several scientific projects, financed by the National Science Fund and Scientific Fund of Sofia University "St. Kl. Ohridski". Currently he is a coordinator of the consortium "Sub-micron machining and analysis of materials and structures using scanning electron microscopy in combination with focused ion beam", comprising several Bulgarian universities and scientific organizations, financed by the National Science Fund of Bulgaria.

Assoc. Prof. Russev prepared and delivered lectures on the following university courses: Ellipsometry, Physics of discrete semiconductor devices, Information technology in microelectronics, Programming and computational physics and numerous practical exercises in the field for bachelor and master degree students.

# AWARDS

## NATIONAL CONTEST FOR YOUNG TALENTS 2009

At the end of May 2009 National Contest for Young Talents in the field of science was held in Sofia, organized by the Ministry of education and science. The participants had to prepare research and innovative projects in three fields: natural sciences, communication and information technologies and social sciences. The awards were bestowed at an official ceremony. Evaluation criteria were as follows: originality of the research idea, independence in preparation of the project and possibility of easy communication and good presentation.

**Vasilina Tatarlieva**, 11-grade student at American College, Sofia **ranked first** in the National Contest for Young Talents with the project "Temperature Mapping through Digital Photography". The aim of the project is developing of a quick and easily accessible method based on digital photography for remote measuring of temperature of strongly warmed bodies. The method allows investigation of temperature space variations. It can be adjusted to any non-professional camera, as well as to a desktop or portable computer.

The jury adjudged the **second place** to **Yoan Delchev** and **Lyuboslav Panchev**, 11-grade students at Sofia High School of Mathematics "P. Hilendarski" for their project in the field of mathematics "A Walk among the Trees". The work proves interesting dependencies, some difficult problems are formulated and two algorithms – combinatory and algebraic - are deduced.

The project "Exploration of Galactic Characteristics and Peculiarities" by **Alexander Kurtenkov** and **Momchil Molnar**, students at Sofia University St. Kl. Ohridski, **ranked third**. The project is a study of galactic peculiarities and finding out the parameters of galaxies. The main purpose is to create a more complete picture of formation and evolution of the standard galaxies by means of exploration of peculiar galaxies.

The projects ranked first, second and third by the jury will present Bulgaria at the European contest for young talents – the most prestigious European forum for young talents which will be held this year in Paris, France.

National contest for young talents has been conducted in the country since 1999 and is one of possibilities for encouraging young people having potential and showing interest in science and research work. The contest is a part of initiatives of the Ministry of Education and Science in support and development of young talents in the country.

## BULGARIAN STUDENTS GAINED SIX MEDALS AT THE BALKAN MATHEMATICAL OLIMPIAD

Two gold and four silver medals were gained by Bulgarian students at the XIII Junior Balkan Mathematical Olympiad held in the beginning of June in Bosnia and Herzegovina.

**Radoslav Komitov**, an 8-grade student from High School of Mathematics "Atanas Radev" in Yambol became a **gold medal** winner with the highest score from national competitions and controls in mathematics before the Olympiad. Another **gold medal** was won by **Ivo Kortezov** from Sofia High School of Mathematics "P. Hilendarski".

**Silver medal** winners are **Petar Penkov** and **Pavlena Nenova** from Sofia High School of Mathematics "P. Hilendarski", **Kristian Mitov** from High School of Mathematics and Natural Sciences "Exarch Antim I" in Vidin and **Todor Markov** from High School of Mathematics and Natural Sciences "Acad. N. Obreshkov" in Burgas.

Bulgaria ranked second after Romania with only 1 point difference.

The competition is for young people aged up

to 15 years and a half, and our national team was selected by an 8-member commission chaired by Prof. DSc Sava Grozev, whose professional way is closely connected with the most talented young mathematicians in Bulgaria.

For the first time the Olympiad was held in Belgrade in 1997. Bulgaria hosted the competition twice – in 1999 in Plovdiv and in Shumen in 2007. Balkan countries have the right to participate, but during recent years guest teams from outside the region take part in it, too.

## BULGARIAN STUDENTS RETURNED WITH SIX MEDALS FROM THE MATHEMATICAL OLYMPIAD IN BREMEN

Our representatives won high distinctions at the 50-th International Mathematical Olympiad in Bremen, Germany, which was held on July 14 to 21, 2009.

**Lyuboslav Panchev**, 11-grade student from Sofia High School of Mathematics, won **gold medal**.

**Svetozar Stankov** from Sofia High School of Mathematics, **Zhivko Zhechev** from High School of Mathematic and Natural Sciences in Shumen and **Svetoslav Karaivanov** from National High School of Mathematics and Natural Sciences became **silver medalists**.

Two **bronze medals** were gained by **Galin Statev** from the National High School of Mathematics and Natural Sciences and **Viktor Valov** from Sofia High School of Mathematics.

The Chairperson of the National Assembly Mrs. **Tzetzka Tzacheva** sent a congratulatory address to the leader of the Bulgarian national team Senior Research Assoc. Prof. **Nikolai Nikolov** (IMI – BAS) and to the students of the team on the occasion of their successful participation in the Olympiad.

565 students from over 100 countries took part in the jubilee Olympiad.

## EIGHT MEDALS FOR BULGARIAN STUDENTS FROM INTERNATIONAL OLYMPIAD IN INFORMATICS

In August 2009 the XXI International Olympiad in Informatics was held in Plovdiv. 309 students from 89 countries took part in the extremely contested competition. The contestants were regular students from high schools up to 20 years old.

**Silver medal** with the highest result among Bulgarian students was gained by **Rumen Hristov** from High School of Mathematics and Natural Sciences "Nancho Popovich" in Shumen. **Momchil Tomov** from High School of Mathematics "Geo Milev" in Pleven, **Stefan Avramov** from High School of Mathematics and Natural Sciences "Vasil Drumev" in Veliko Tarnovo and **Momchil Ivanov** from High School of Mathematics and Natural Sciences "Nancho Popovich" in Shumen were also decorated with **silver medals**.

**Bronze medals** for the Bulgarian team were gained by **Ivan Georgiev** from High School of Mathematics "Geo Milev" in Pleven, **Anton Atanasov** from High School of Mathematics and Natural Sciences "Acad. Boyan Petkanchin" in Haskovo, **Mikhail Kovachev** from High School of Mathematics and Natural Sciences "Nancho Popovich" in Shumen, **Yasen Trifonov** from the Model High School of Mathematics in Plovdiv.

Absolute champion of the Olympiad is 14-year old student **Genadzi Karatkevich** from Belarus. He was awarded with a **gold medal** and a statuette "John Atanasoff" handed to him by **Svetlana Lomeva**, Deputy Minister of education, youth and science.

The idea of international Olympiad in informatics for students was presented by Acad. Blagovest Sendov at the 24-th general conference of UNESCO held in Paris in 1987. The plan for conducting the competition is included in the

Fifth main program of UNESCO. In 1989 UNESCO gave its consent and sponsored organization of the First International Olympiad in Informatics which was held in Bulgaria in May of the same year.

The Olympiad in Informatics is a world-wide competition held every year.

# ARTICLES

## RECENT PUBLICATIONS OF BULGARIAN SCIENTISTS

**Title:** **Building of scientific information system for sustainable development of BNCT in Bulgaria.**

**Authors:** Mitev, M.[1] mlmitev@inrne.bas.bg, Ilieva, K.[1], Apostolov, T.[1]

**Source:** Applied Radiation & Isotopes, Vol. 67, 7/8, (Jul. 2009), Supplement, S296-S298

**Author Affiliations:** [1]Institute for Nuclear Research and Nuclear Energy of the Bulgarian Academy of Sciences, 72, Tsarigradsko shosse Blvd., Sofia, Bulgaria

**ISSN:** 0969-8043

**Title:** **Components of Environmental Literacy in Elementary Science Education Curriculum in Bulgaria and Turkey.**

**Authors:** Erdoğan, Mehmet[1], mehmederdogan@yahoo.com, Kostova, Zdravka[2], Marcinkowski, Thomas[3]

**Source:** Eurasia Journal of Mathematics, Science & Technology Education, Vol. 5, 1, (Feb. 2009), 15-26, 4 charts

**Author Affiliations:** [1]University of Akdeniz, Antalya, Turkey
[2]Kliment Ohridski University, Sofia, Bulgaria
[3]Florida Institute of Technology, Melbourne, FL, USA

**ISSN:** 1305-8223

**Title:** **Monitoring lunar radiation environment: RADOM instrument on Chandravaan–1.**

**Authors:** Dachev, T.[1], tdachev59@gmail.com, Tomov, B.[1], Dimitrov, P.[1], Matviichuk, Y.[1]

**Source:** Current Science, Vol. 96, 4, (Feb. 2009), 544-546, 1 diagram, 1 graph

**Author Affiliations:** [1]Solar-Terrestrial Influences Laboratory, Bulgarian Academy of Sciences, Sofia, Bulgaria

**ISSN:** 0011-3891

**Title:** **EARLINET: the European Aerosol Research Lidar Network for the Aerosol Climatology on Continental Scale.**

**Authors:** Pappalardo, Gelsomina[1], pappalardo@imaa.cnr.it, Bösenberg, Jens[2], Amodeo, Aldo[1], Ansmann, Albert[3], Apituley, Arnoud[4], Arboledas, Lucas Alados[5], Balis, Dimitris[6], Böckmann, Christine[7], Chaikovsky, Anatoly[8], Comeron, Adolfo[9], D'Amico, Giuseppe[1], Freudenthaler, Volker[10], Grigorov, Ivan[11], Hansen, Georg[12], Linnè, Holger[2], Kinne, Stefan[2], Mattis, Ina[3], Mona, Lucia[1], Mueller, Detlef[3], Mitev, Valentin[13]

**Source:** AIP Conference Proceedings, Vol. 1100, 1, (Mar. 2009), 189-192, 1 diagram, 1 graph

**Author Affiliations:** [1]Istituto di Metodologie per l'Analisi Ambientale CNR-IMAA, C.da S. Loja, Tito Scalo, Potenza, Italy I-85050
[2]Max-Planck-Institut für Meteorologie, Hamburg, Germany
[3]Institut für Troposphärenforschung, Leipzig, Germany
[4]Rijksinstituut voor Volksgezondheid en Milieu, Bilthoven, The Netherlands
[5]Universidad de Granada, Granada, Spain
[6]Aristoteleio Panepistimio, Thessalonikis, Greece

[7]Institut für Mathematik der Universität Potsdam, Germany
[8]Institute of Physics, National Academy of Sciences, Minsk, Belarus
[9]Universitat Politècnica de Catalunya, Barcelona, Spain
[10]Ludwig-Maximilians-Universität, München, Germany
[11]Institute of Electronics, Bulgarian Academy of Sciences, Sofia, Bulgaria
[12]Norwegian Institute for Air Research at the Polar Environmental Centre, Tromsö, Norway
[13]CSEM, Centre Suisse d'Electronique et de Microtechnique SA, Neuchâtel, Switzerland
**ISSN:** 0094-243X

**Title:** **Biodynamics – A new science field?**
**Authors:** Teodorova, S.E.[1]
**Source:** Research Journal of Chemistry and Environment, Vol. 13, 2, (Jun. 2009), 99-103
**Author Affiliations:** [1]Institute for Nuclear Research and Nuclear Energy, Bulgarian Academy of Sciences, 72, Tzarigradsko shosse Blvd., 1784 Sofia, Bulgaria
**ISSN:** 0972-0626

**Title:** **Plant cells and algae in bioreactors.**
**Authors:** Pavlov, Atanas[1]
**Source:** Engineering in Life Sciences, Vol. 9, 3, (Jun. 2009), 154-155
**Author Affiliations:** [1]Bulgarian Academy of Sciences, Stephan Angeloff Inst. Microbiol., Plovdiv, Bulgaria
**ISSN:** 1618-0240

**Title:** **Resonance data for self-shielding problems.**
**Authors:** Janeva, N.[1], Lukyanov, A.[1], Koyumdjieva, N.[1]
**Source:** International Conference on Nuclear Data for Science and Technology, Vol. 1, Proceedings, (2008), 659-662
**Author Affiliations:** [1]Bulgarian Academy of Sciences, Inst. Nucl. Res. & Nucl. Energy, BU-1784 Sofia, Bulgaria
**ISBN:** 978-2-7598-0090-2

**Title:** **Distribution of Video-on-Demand Service over Cable Television Networks.**
**Authors:** Jordanova, L. T.[1], Nenkov, J. I.[1]
**Source:** Radioengineering, Vol. 18, 2, Part 2, (Jun. 2009), 242-247
**Author Affiliations:** [1]Technical University, Faculty of Telecommunications, 1756 Sofia, Bulgaria
**ISSN:** 1210-2512

**Title:** **Research Note on a Parabolic Heat-Balance Integral Method with Unspecified Exponent: An Entropy Generation Approach in Optimal Profile Determination.**
**Authors:** Hristov, Jordan[1]
**Source:** Thermal Science, Vol. 13, 2, (2009), 49-59
**Author Affiliations:** [1]University of Chemical Technology and Metallurgy, Dept. Chem. Engn., BU-1756 Sofia, Bulgaria
**ISSN:** 0354-9836

| | |
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| **Title:** | **Preliminary modeling of BNCT beam tube on IRT in Sofia.** |
| **Authors:** | S. Belousov[1], K. Ilieva[1] |
| **Source:** | Applied Radiation and Isotopes, Vol. 67, 7-8, Supplement 1, (Jul. 2009), S230-S233, 13th International Congress on Neutron Capture Therapy BNCT: a new option against cancer |
| **Author Affiliations:** | [1]Institute for Nuclear Research and Nuclear Energy (INRNE) of the Bulgarian Academy of Sciences, 72, Tsarigradsko shosse Blvd., Sofia, Bulgaria |
| **ISSN:** | 0969-8043 |

# EVENTS

## EUROPEAN RESEARCHERS NIGHT IN BULGARIA

The aim of all activities in European countries is to provoke broad interest to researchers and their role in economic and social development of the society, as well as in improvement of quality of life. Different events give chances for children and their parents to see scientists in a different light from that in which the society usually see them – in front of research equipment or computers, in laboratories and research rooms or at conferences and symposiums.

In Bulgaria the project dedicated to Researchers Night 2009 - STAR NIGHT is realized by a consortium with participants: Sofia Technical University (coordinator), Young Talents Club, Information and Improvement of Teachers' Qualification Department at Thracian University – Stara Zagora, University Angel Kanchev – Ruse, Union of Bulgarian Astronomers, Medical University – Plovdiv, Plovdiv municipality and Academy for Dance, Music and Fine Arts and with partnership at the national and local level of the Union of Scientists in Bulgaria, Union of Physicists in Bulgaria, museums, municipalities and many other organizations.

On September 25, 2009 various entertaining events took place in Sofia, Plovdiv, Ruse, Stara Zagora, Varna, Shumen, Yambol, Silistra, Pleven, Haskovo and Dimitrovgrad. Most of them were connected with the International Year of Astronomy 2009, 30 years from the first Bulgarian cosmonaut Georgi Ivanov's flight and to the 140-th anniversary from foundation of the main and the oldest research institution in our country – Bulgarian Academy of Sciences. The multiform program included exhibitions, awarding prizes to winners in young talents competitions, entertaining demonstrations at Curiosity Laboratories, scientific shows, film-shows and poetry recitals by scientists, etc.

In **Plovdiv** the program of the Researchers Night included:

**Laboratory in the street** – attractive research experiments, demonstrations and tests presented by scientists from Plovdiv;

**Research Café** – lectures by famous Bulgarian scientists in informal environment;

**Academic Variety Show** – artistic manifestations of researchers in all genres: music, dance, poetry, dramatic art;

**Exhibition of paintings and art photography** by representatives of the academic community;

**LAN party** for young people of Plovdiv with inquiry and live forum on the subject **"Research Career – Pros and Cons"**;

**Search for Treasure** – an amusing game for schoolchildren with questions connected with scientific discoveries and facts.

In **Ruse** the project presented a number of initiatives dedicated to astronomy and physics with participation of schoolchildren, students, graduate and post-graduate students and scientists.

Under supervision of university lecturers and teachers in astronomy and physics at the English Language High School in Ruse its alumni developed papers which were presented before professional jury at the Round Table on September 25.

"Curiosity Laboratories" were created in the University. Students, graduates and post-graduates prepared there mini-models of 10 prototypes of modern technologies of Quick prototyping.

From September 21 to 25 schoolchildren from the English Language High School Geo Milev organized an ASTRO-photo exhibition of interesting natural phenomena. During the week and

the European Researchers Night itself a film made by researchers from Ruse for ASTRO-science series was presented in University of Ruse.

The celebrations rounded off with ASTRO-party with scientists, which included a thematic quiz, entertaining program and official awarding of the distinguished works.

**In Sofia**

Euro Integration and Information Association for the second year in succession organized a **competition for journalists on the subject "Peak Achievements of Bulgarian Scientists"** within the Researchers Night 2009 initiative dedicated to astronomy and new technologies. The purpose of the competition was to popularize among the general public the newest achievements of Bulgarian science, to illustrate its specific and unknown to the society aspects.

Technical University Sofia and Young Talents Club organized a consecution of contests and exhibitions to popularize science among young people. In connection with the International year of Astronomy there was organized a jubilee exhibition with exhibits and materials on the history of Bulgarian astronomy, and "Grace and Gravitation" Discussion Club. Funded by EC, the film "Eyes to the Sky" by the European Space Agency was translated into Bulgarian. It was distributed in 3000 schools and was shown during the Researchers Night. An exhibition of posters on the subject "Bulgarian Trace in Science" was also organized in connection with the 140-th anniversary of the Bulgarian Academy of Sciences. Names of Bulgarian scientists working in the field of natural sciences were included in it.

**31 October – 1 November 2009**

INTERNATIONAL CONFERENCE
**"ALTERNATIVE TOURISM THEORY AND PRACTICE"**
Varna, Bulgaria
Address:
Institute of Geography, Bulgarian Academy of Sciences
Acad. G. Bonchev Str., bl.3, 1113 Sofia, Bulgaria
Phone/Fax: (+359 2) 870 02 04
E-mail: geograph@bas.bg

**30 October – 1 November 2009**

THE SOUTH-EAST EUROPEAN REGIONAL CONFERENCE OF PSYCHOLOGY
**SEERCP 2009**
Sofia, Bulgaria
Address:
Bulgarian Psychological Society (BPS)
52, Cherkovna Street, suite 2, 1505 Sofia, Bulgaria
Phone: (+359 2) 843 5854; (+359 888) 429 730
E-mail: office@psychology-bg.org
Web site: http://rcp2009.wordpress.com/

**4 – 5 November 2009**

SECOND INTERNATIONAL CONFERENCE
**"ENERGY AND CLIMATE. NEW PRIORITIES"**
Hilton Hotel, Sofia, Bulgaria
Address:
69, Evlogi Georgiev Blvd., 1000 Sofia, Bulgaria
Phone: (+359 2) 980 86 89
E-mail: energia_ecologia@abv.bg
Web site: http://www.energyconferencebulgaria.eu/

**6 – 7 November 2009**

19TH INTERNATIONAL SCIENTIFIC CONFERENCE
**TRANSPORT 2009**
Sofia, Bulgaria
Address:
Todor Kableshkov Higher School of Transport
158, Geo Milev Street, 1574 Sofia, Bulgaria
Phone: (+359 2) 9709 335; (+359 2) 9709 384
Fax: (+359 2) 9709 242; (+359 2) 9709 325
E-mail: conference@vtu.bg

**19 – 20 November 2009**

XI NATIONAL CONFERENCE ON
**PLANT PHYSIOLOGY** with International Participation
Sofia, Bulgaria
Address:
Institute of Plant Physiology, Bulgarian Academy of Sciences
Acad. G. Bonchev Street, Bldg. 21, 1113 Sofia, Bulgaria
Fax: (+359 2) 8739952
E-mail: conf09@bio21.bas.bg

**3 – 4 December 2009**

1st National Conference with International Participation
on BIOMEDICAL AND BIOPROCESS ENGINEERING
**BM & BP'2009**
Sofia, Bulgaria
Address:
Centre of Biomedical Engineering,
Bulgarian Academy of Sciences
105, Acad. George Bonchev Str., 1113 Sofia, Bulgaria
Phone: (+359 2) 979 3647; Fax: (+359 2) 872 3787
E-mail: tania.pencheva@clbme.bas.bg
Web site: http://www.clbme.bas.bg

**3 – 4 December 2009**

NATIONAL CONFERENCE WITH INTERNATIONAL PARTICIPATION
**"GEOSCIENCES 2009"**
Sofia, Bulgaria
Address:
Sofia University "St. Kliment Ochridski", Faculty of geology and geography
15, Tsar Osvoboditel Blvd., 1000 Sofia, Bulgaria
Phone: (+359 2) 9308552; (+359 2) 9446487
E-mail: vassilka@gea.uni-sofia.bg

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