

Reliance on High Technologies



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The Department of Physics, Mathematics and Informatics of the National Academy of Sciences of Belarus coordinates fundamental and applied work on priority scientific directions with account of the world science trends, available potential and the country's economy demands. The Department includes 3 state research institutions.

B.I. Stepanov Institute of Physics carries out research in the field of laser physics, nonlinear and quantum optics, creates new laser optical devices and technologies for industry, medicine, ecology, control systems, metrology and certification. It is engaged in the development, introduction of optical methods of research into the properties of molecular structures and nanomaterials and their production methods. Much attention is given to plasma physics, development and practical application of plasma technologies. Physical and technological foundation is being laid for the creation of competitive products of micro-, opto- and nanoelectronics. Research into particle physics, fundamental interactions, nuclear reactions and nuclear spectroscopy is underway.

Among the most important results of fundamental research obtained in recent years, it is necessary to mention as follows:

- obtaining, for the first time in the world, continuous generation in a SRS laser based on crystalline scattering media. Devices based on these media hold much promise for biology, medicine, and spectroscopy. There were also suggested and implemented methods of SRS-conversion of the radiation frequency of microchip lasers excited by continuous emission from laser diodes;
- development of original methods for obtaining and nonlinear transformation of Bessel light beams and other beams of nontrivial structure, which provides fundamentally new opportunities for practical application of laser radiation in medicine, profilometry, inspection of microelectronic products and in other fields.
- creation of the world-first semiconductor heterostructure lasers working in the blue region of the spectrum and a laser source converting blue radiation into green light. This opens the door to building new integrated optoelectronic systems;

The work of the Institute's researchers is aimed not only at solving fundamental physical problems but also at creating new knowledge-intensive products and technologies. For example, the created high-sensitivity methods of laser atomic spectral analysis may be used for the study of cultural heritage objects, attribution of the exhibits of the National Arts Museum and the State Historical Museum as well as in criminalistics.

Over 500 pieces of laser optic devices developed by the researchers and designed for treating a wide range of diseases were supplied to medical establishments of our country. They are *Rodnik-1*, *Aibolit*, *Seans*, *SNAG*, *Malysh*, *Romashka* — totally to more than BYR 2.5 billion. Introducing *Malysh* apparatuses into medical practice fully satisfied the country's demand for high-effectiveness devices for treating icterus of the newborn while the *Romashka* complexes considerably increased the treatment effectiveness in patients suffering from different kinds of wounds, traumas and pathologies.

LED-type illumination, signaling and information devices are manufactured for enterprises of Belarus and Russia. A laser vision system for heavy-duty trucks operating in inclement weather conditions is being developed for BelAZ. For the Department of State Marks of the Ministry for Finance of the Republic of Belarus, there were created and introduced new methods and technologies for protecting securities, documents and goods. Two types of conventionally eye-safe laser radiation sources are being designed jointly with the UE *LEMT* and *Peleng* PLC for the needs of the defense complex of the country. The Ministry for Nature and Environmental Protection is interested in the regularly conducted lidar monitoring of the atmosphere and transboundary pollution of air.

The Institute of Physics actively participates in international scientific-and-technological cooperation. Only during the recent 2.5 years, over USD 2.5 million have been attracted from foreign countries for funding different projects.

Research workers from the **Institute of Mathematics** are engaged in fundamental research in the field of algebra,

geometry and theory of numbers, differential equations, system optimization and control methods, functional analysis, numerical mathematics, discrete models and algorithms, probabilistic/statistical analysis and theory of random processes. The investigations carried out by the researchers are aimed not only at the development of fundamental mathematical problems. New mathematical models and methods are being created for solving urgent applied problems occurring in cryptology, physics, mechanics, microelectronics, technology, economics, ecology, medicine, oil-processing industry, metallurgy, construction, logistics, and theory of traffic networks as well as in designing and operating emergency-protecting systems and in other fields.

The researchers of the **Joint Institute of Informatics Problems** have received a series of significant fundamental results in complex system modeling, image processing and pattern recognition (in industry, medicine, data of remote sensing of the Earth), text-to-speech synthesis; analysis methods for complicated nonlinear dynamic systems were created, etc. These scientific results are being successfully introduced at Belarusian enterprises. Over 40 medical establishments were equipped with more than 700 automated workstations which encompass all levels of activity, beginning with a separate workplace for a doctor and ending with a system for an entire region which helps improve the diagnosis quality, relevancy of medical decisions, cost efficiency and treatment-and-diagnosis effectiveness.

Jointly with Belarusian medical scientists, there was developed and put into permanent operation a CIS-unique distributed telemedical system of digital on-line fluorography based on the



The model of the femtosecond SRS-amplifier on a Raman-active crystal



Malysh apparatuses for treating icterus in the newborn are widely used in maternity hospitals of the country



The lidar complex of the Institute of Physics is among the world's best ones

2nd city TB dispensary and 20 Minsk city out-patient clinics. It improves early detection of lung diseases. So far, there have been conducted over 100 thousand telemedical consultations and the system is expected to encompass the entire capital. Its core is a supercomputer of the *SKIF-Triada* personal clusters family, created jointly with the Research Institute of Electronic Computer Machines within the framework of the *Triada* program of the Union State of Russia and Belarus and exhibiting a range of performance between 50 and 500 Gflops. Earlier, the researchers of the Institute had made a significant contribution to the creation of the *SKIF* supercomputer, some models of which were on current lists of the world's top performance computer systems.

The first phase of an integrated information and organizational-and-technological structure of virtual business processes in the field of design, preproduction engineering, control, sale and use of products was developed within *CALS-Technologies* state scientific-technical program (to the order of the Ministry of Industry).

The Joint Institute of Informatics Problems is developing digital ground mapping technologies for the navigational survey service of the Armed Forces of the Republic of Belarus.

There was created and put into service the national automated information system of forming and keeping a record library and automated record banks for the Ministry of Internal Affairs. Its first phase encompasses 58 Ministry's subdivisions located in 30 towns and cities. This system is expected to cover all the regions of the country.

It is necessary to point out the coordination and performance of work in the field of space problems. Jointly with interested organizations, ministries and departments, the Institute formed and the

Council of Minister approved the *National Program for Exploration and Use of Outer Space for Peaceful Purposes for the Period of 2008—2012*; there started the execution of the new *Kosmos-NT* program of the Union State of Russia and Belarus; works on the creation of the Belarusian space-based system of remote sensing of the Earth are in progress.

The Department also incorporates two research engineering republican unitary enterprises which deal with practical implementation of the research results.

The Research Engineering Republican Unitary Enterprise Geoinformation Systems created hardware/software complexes for processing satellite information designed for spotting forest and peat bog fires, controlling aerosol and gas contamination of the atmosphere, analyzing the environment after accidents aggravated by the emission of toxic substances; tools for generating digital elevation models, updating digital maps and plans. There were developed technologies for forest resources assessment, monitoring and remote sensing of forests, forest management on the Belarusian and Russian territories contaminated with radionuclides, the basic module of a corporate geoinformation system for use in the state system of prevention and elimination of emergency situations at a national, regional, district and object level.

The Inter-Branch Scientific-Practical Center for Identification and Electronic Business Operations performs a complex of technological works on managing databases of goods marked with barcodes or radiofrequency identification tags. Service is provided to over 2.7 thousand Belarusian manufacturers who mark their products with international barcodes and the barcode depository contains about 3 million item names. The Center has formed the country's first test laboratory

for barcode verification and a pilot system of logistics which provides warehouse logistics and logistics of goods and packing marked with RFID tags.

The research organizations of the Department of Physics, Mathematics and Informatics perform works on 206 assignments of state programs of fundamental and applied research, 175 projects of the Belarusian Republican Fundamental Research Fund. They coordinate the state programs *Electronics, Photonics, Fields and Particles* (the head organization is B.I. Stepanov Institute of Physics), *Mathematical Models* (Institute of Mathematics), *Infotech, Reducing Emergency Situation Risks* (Joint Institute of Informatics Problems). These Institutes have research councils on corresponding programs. The Department researchers are also carrying out about 240 scientific-technical developments. In 2007—2008, they published 24 monographs, 17 textbooks and training aids, 23 collections of scientific papers, over 1650 research articles and reports, about a thousand of paper theses; defended 7 doctoral and 26 candidate's dissertations. They filed about 200 applications for a title of protection for industrial property objects and obtained 180 positive decisions.

The strategic task of scientific provision and development of the scientific and innovation sphere of the country is still topical in the plans of the research organizations of the Department of Physics, Mathematics and Informatics for 2009. It will be necessary to focus the scientific potential on fundamental and applied research in the field of optics and laser physics, electronics, plasma physics, molecular physics, physics of fundamental interactions, fundamental and applied mathematics, information technologies. These are the directions on which financial, material and human resources should be focused.