

BULGARIAN SPACE STUDIES – PAST, PRESENT, AND FUTURE

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Bulgarian participation in space conquer is impressive, systematic, and effective. It started in 1969 when, at the Presidium of the Bulgarian Academy of Sciences (BAS), a research group in Space Physics was established. With the course of time this group grew into the Central Laboratory for Space Research (CLSR), and later, into the Space Research Institute (SRI). Meanwhile, more than 100 units, equipment, and systems were designed and launched in space.

In 1972, Bulgaria launched its first space equipment, P-1, onboard the *Intercosmos-8* satellite. Later, this equipment operated on the *Intercosmos-12 and 14* satellites, on the *Vertical-3, 4, 6, and 7* heavy geophysical rockets, and on a number of other meteorological rockets. At this time, a series of space units were designed at the CLSR, mainly in the field of Space Physics and Remote Sensing of the Earth from Space where some unrivalled achievements and unique equipment were made.

Under the *Intercosmos* Program were developed 19 joint satellites and automatic stations, 7 heavy geophysical rockets, and about 60 meteorological rockets. Bulgarian equipment and systems were flown on 4 *Intercosmos* satellites, 4 *Vertical* heavy geophysical rockets, and 5 *M-100* rockets. Bulgaria became the 18th country to launch space equipment and conduct space experiments. The plasma research units P-2, P-3, and X-4 flown later as a part of different satellite equipment were also very successive.

Bulgaria was specialized in the development of space electrophotometers for weak light emissions in Earth-surrounding space and planet atmosphere. These stations were used to measure the light emission of nightly skies in Cuba, India, and Guinea.

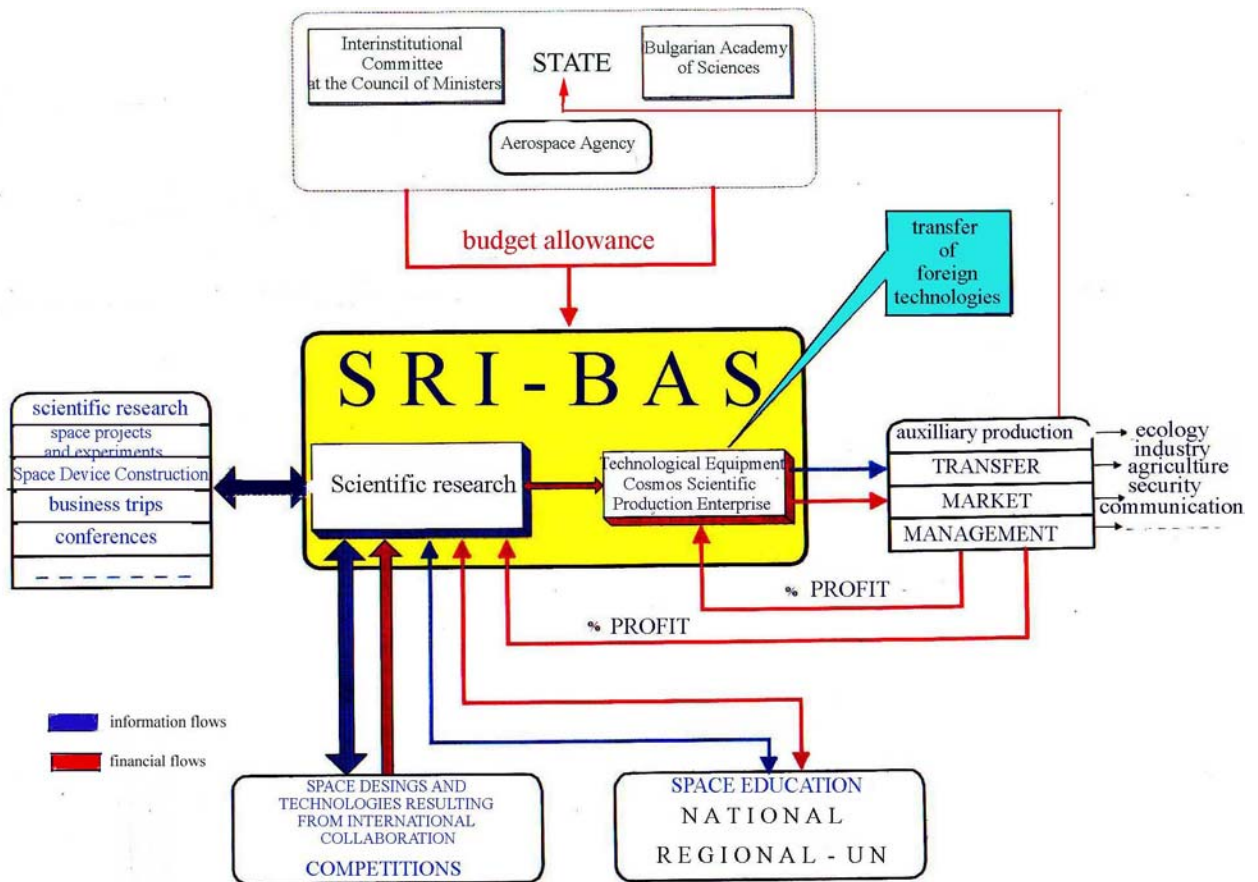
The Bulgarian units *ISOH-20* measuring the spectral reflection characteristics of soils, agricultural crops, rocks, and water have operated in Russia, Cuba, and Poland.

The apogee of Bulgarian space research achievements was the development of the research programs of the two Bulgarian astronauts including 11 units and systems by which more than 60 space experiments were conducted.

The activity of the SRI might be provisionally divided into several periods. First was the so-called *child* period related with mankind's first steps in space. Next came the *romantic* period part of which was described above. Its aim was to provide an answer to scientific curiosity but, quite often, it was as well an arena of political and technological rivalry between the two systems. Now we are in the so-called *pragmatic* period where space studies face mostly the problems of the Earth, aiming to solve the topical tasks of mankind related with ecology, communication, navigation, meteorology etc.

The restricted financial potentials of the country called for the need of concentrating researchers efforts on a nation-wide scale to prevent different institutions from performing more or less similar activities. To this end, the Council of Ministers founded an Interinstitutional Committee on Space Issues that adopted a National Program for Space Studies.

This program's implementation is to be based on market approach, competitiveness, targeted funding, and program teams which actually means the mode of operation of space studies in Bulgaria is going to be changed (Fig.1).



Accounting for the Committee's resolutions, the SRI which is the base BAS institution in the field of space studies undertook some serious actions to the implementation of these new commitments, specifying precisely the sources to fund its activity.

First, we believe that the budget funds provided by BAS to support the Institute must be spent on purpose through the organization of program teams to work on contract tasks with specified assignors, terms, and funding. This mode of operation calls for active science management where all the elements of scientific studies in the developed countries will be available.

As a second source of funding we regard participation in the international allocation in the field of space studies.

Since, so far, the developed western countries are the solvent ones, we try to establish international cooperation with them participating in various competitions, projects, or activities. The Institute has great experience in this field. Some of the successful projects in this field are **Corine Land Cover** and **PHARE-MERA** funded by Western Europe, the **SVET Space Greenhouse**, and the system for complex study of the astronauts psycho-physiological status, **Neurolab-B**. The last two projects, funded respectively by American and German institutions, were launched onboard the **MIR** Orbital Station (OS). In 1998, Bulgaria signed with Italy an Intergovernmental Agreement for Scientific-Technical Collaboration. A detailed Concept for the implementation of **7 projects** was elaborated that provoked the keen interest of a number of Italian universities, research centers, and space companies. Italy is expected to provide options

for mounting of scientific equipment onboard of the International Space Station (ISS) to be launched in September 2003 (within the module of the European Space Agency, ESA). In 2000, activities were started for Bulgaria's acquisition in the ESA which will greatly expand the opportunities for international participation.

The continuation of Bulgaria's collaboration with Russia is of great importance to the development of space studies. Since 1997 the Institute participates in the *Priroda* International Project which was realized on board of the *MIR* OS, based on the module bearing the same name.

A contract was concluded with our traditional partner, the State Research Center of the Russian Federation, the Institute of Medico-Biological Problems (IMBP), for scientific-technical collaboration to the development of a life-support system (LSS) for the long-term missions of the future space crews, based mostly on higher plants. Yet in 1997, a suggestion was forwarded to the Russian Space Agency for the inclusion of a new modification of the *SVET-3* Space Greenhouse in the biological research program of one of the Russian modules onboard of the ISS. Unfortunately, so far the project has been postponed for financial reasons.

Since 2000, teams from the Institute participate in **3 projects under the Fifth Frame Program of the European Community: Use of Space Images in Thematic and Cadastre Mapping for the Purpose of Agricultural Restructuring and Privatization with a View to Sustainable Development of the Environment**, and two projects in the field of Space Material Science.

Following the nearly ten-year long drop of the international research community's interest towards the study of Earth-surrounding plasma, recently, a growing interest has been witnessed in the field. Two global programs were initiated, namely: **Monitoring of Earth Catastrophes from Space** and **Space Time**. It is worth emphasizing that Bulgarian and Russian experts were the first in *Intercosmos* to address the problem of using space data for studying the reaction of ionospheric-magnetospheric plasma to forthcoming earthquakes. An essential part of the future studies in the SRI and its participation in satellite experiments will be related to the study of ionospheric-seismic effects and the options for using them as a precursor. The immediate future will witness the accomplishment of the **Predvestnik (Precursor) Projects**. The **Space Time Program** is aimed at studying both the direct and indirect (through anthropogenic systems and equipment) impact of Earth-surrounding space on man. Another topic of interest to Space Physics is the study of geomagnetic storms, development of models related with the reaction of ionospheric-magnetospheric plasma, dynamics of solar wind, operation of space units and equipment at the time of geomagnetic storms.

A team of the Institute is working on an international contract jointly with researchers and experts from the Institute for Problems of Material Science (IPMS) at the Ukrainian National Academy of Sciences and on the **BALKANBEARINGS United Project** under the EUREKA Program of the European Union in the field of new technological materials and covers to operate under extreme conditions.

We are resolved to find a way to participate in the projects of the ISS. The SRI has concluded a contract with the Brazilian company **BRAZSAT**, the only trade company in Latin America that coordinates their space programs onboard of American space shuttles. Through it we plan to design a space green house for the ISS.

Researchers of the SRI-BAS have been dealing for many years with the theoretical and technical problems of **space navigation**. This direction is of strategic importance since there is no airplane or ship already that does not use satellite navigation. The overall control of air and sea traffic, and recently also of land traffic is based on space navigation. It is also being introduced on a large scale in cars and this is going to result in a boom in the field of car construction and prevention of car theft that will have great economic and scientific-technical consequences.

Accounting for this fact we opened a **subsidiary in the town of Plovdiv** which will work only with navigation and communication.

In the next years, the construction of the *Galileo* Global European Navigation System will start which we are willing to join as well.

The active participation in international competitions and projects calls for a serious policy in staff selection and young researchers development. To this end we should:

- **incorporate young researchers** in the Institute by organizing competitions to the formation of program teams;
- **allow science leaders to emerge naturally** in the process of looking for and formulation of financially provided tasks of public significance. Gradually, the artificial structures and positions will fade away since they are funded only by the budget which gets more and more restricted;
- **replace the available assisting-technical staff by younger people.** This is going to take place gradually in the process of performing the activities related to the contract tasks these people will be involved in. In the recent years many of them lagged behind in their qualification, so, in looking for new tasks we should look as well for new people with new thinking, possessing the needed qualification;
- **make wide use of the need for lecturers and researchers of the universities and higher institutes.** This will not only preserve the competitiveness of our scientists and enable them to get some additional remuneration, but it will also provide an opportunity to detect the young people needed to solve the tasks in the field of space studies.

The solution of our strategic tasks may be also funded through implementation of the obtained results, minding the predominating applied-scientific or technological nature of the researches. We shall be greatly assisted in this respect by the forthcoming High-Tech Parks Act. We plan to create such a high-tech park based on the *Cosmos* Research-Production Enterprise located in the town of Stara Zagora and the technological sections and laboratories located in the city of Sofia and the town of Shoumen.

This technological center will assist us implement in practice both our, and foreign technological achievements. A bright example of this trend is the implementation of the **PLEVEN-87 equipment** flown with the second Bulgarian astronaut, Alexander Alexandrov, in the army, transport, industry, and the psycho-physiological studies of dispatchers, pilots, drivers, operators of complex systems etc.

The **NEUROLAB-B psycho-physiological complex** designed jointly with German scientist, currently operating in space, will be used, upon adequate adaptation, in hospitals and clinics, and will probably be competitive in price and potentials to similar medical equipment.

During the recent years, the small-sized multi-channel **HOLTER system** was designed in the SRI intended to record physiological parameters such as electrocardiogram, respiration, blood pressure, temperature etc. At the moment, the system is being tested in English clinics.

Contracts were also signed with the Japanese company **CORE** for the development of communication systems software products. Work is underway on a technical mission of the German company **Dedo Weigert Film**, Munich, for design of dedicated secondary power supply sources.

The **Laboratory for Study and Repair of Gyroscopic Units and Aggregates** founded at the SRI is licensed by the Ministry of Transport. It provides service to most Bulgarian aviation

companies. It will intensify its activity by participating in the updating and service of military avionics.

The introduction of an expert computer system for selection of soldiers-to-be for the Bulgarian army that has been developed for nearly 10 years by the institutes of BAS is forthcoming. It is foreseen to use this system in the transition to a professional army and in the recruitment of post-graduate students for the needs of the Ministry of Defense.

We have concluded contracts with the Technological Institute for Supersolid and New Carbon Materials, Troitsk, Russia, Morgen Ceramics Company and Oryx Technology, CA, USA. Now, diamond pads for assembly of microelectronic components are studied. Heat conductivity of 860 Watt/Kelvin.m has been achieved. The assembly of hot press is forthcoming for compacting of these pads that are awaited for on the USA market.

Bulgaria has an access to space images provided by both its western and Russian partners.

In the recent 10 years, research and applied activity in the field of remote sensing and geographic information systems is continuing. A digital map of the **Central Balkan National Park** is being created, a project for preservation of biological diversity funded by a Bulgarian-Swiss program.

The Institute is licensed to distribute images through the Russian state company **SOVINFORMSPUTNIK**. A contract has been signed with the Greek center for space images **Space Imaging Europe S.A.** about the space images taken from the American satellites **IKONOS**.

The Institute relies on its high-quality experts and equipment (Silicon Graphics and Numelec) for the processing of these images. It has the opportunity to work with the Ministry of Agriculture in relation with the identification of crop quality, the Ministry of Ecology in relation with soil, water, atmospheric, and transborder pollution, mapping of Bulgaria etc.

Systemizing, archiving, and storage of space data is an important element of the activity of the SRI. The interest of some western scientist to our data from **Intercosmos Bulgaria 1300** is notable. In 2001, an agreement was signed with the SRI, Moscow, for joint activity in this field.

Another source of funding shall be the reasonable use of our equipment. The best way to utilize this equipment is:

- to temporarily rent part of the equipment should its being used by ourselves be impossible;
- selling of part of the outdated and multiple equipment so as to accumulate the minimal operative funds needed for buying of new equipment providing for carrying out of modern research.

In conclusion, I would like to point out that pragmatic course of development the Space Research Institute assumed in the recent years will undoubtedly **provide a definite answer** to the question haunting our society in the present hard economic reality: **Does Bulgaria really need to conduct space research nowadays?**

Summarru

- In paper is shown chronology of creation and development on Space Research Institute and observed the most important periods.
- Conception for SRI activities in new condition in Bulgaria is shown.

1 – Interinstitutional Committee at the Council of Ministers

2 – STATE

3 – Bulgarian Academy of Sciences

4 – Aerospace Agency

5 – budget allowance

6 – transfer of foreign technologies

7 – SRI-BAS

8 – scientific research

9 – space projects and experiments

10 – Space Device Construction

11 – business trips

12 – conferences

13 – scientific research

14 – Technological Equipment

Cosmos Scientific Production Enterprise

15 – auxilliary production

16 – TRANSFER

17 – MARKET

18 – MANAGEMENT

19 – ecology

20 – industry

21 – agriculture

22 – security

23 – communication

24 - % PROFIT

25 – information flows

26 – financial flows

27 – SPACE DESINGS AND TECHNOLOGIES RESULTING FROM INTERNATIONAL COLLABORATION
space designs and technologies resulting from international collaboration

28 – COMPETITIONScompetitions

29 – SPACE EDUCATION education

30 – NATIONAL

31 – REGIONAL - UN