



# Academy of Sciences' Research, Technological Programmes Aimed at the Development of the Belarusian Aerospace Sector



# Sustainable Development Goals



UNOOSA

COPUOS: Scientific and Technical Subcommittee  
Fifty-fifth Session (29 January - 9 February 2018)





## United Institute of Informatics Problems

Head Executor carried out the scientific and organizational support of the National Space Programme

## Geo-Information Systems

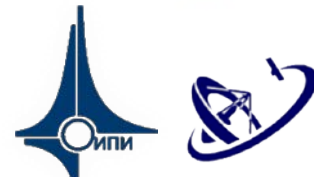
National Operator of the Belarusian Space System for Earth Remote Sensing

### NATIONAL ICT POLICIES KEY RESPONSIBLE BODY

- coordination and state regulation of institutional activities in the exploration and use of outer space for peaceful purposes;
- responsible for national Space Programmes:
  - National Space Programme (2008-2012);
  - **National Space Programme (2017-2020).**

### RELEVANT R&D PARTNERS AND EXECUTORS

- Research and design-engineering institutions of the National Academy of Sciences of Belarus
- Universities and research institutions of the Ministry of Education of Belarus
- Design-engineering and industrial institutions of the Ministry of Industry of Belarus
- Institutions of the State Property Committee
- Other Belarusian design-engineering and industrial institutions

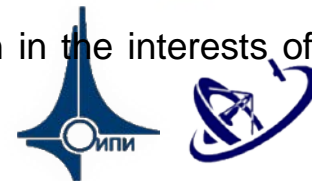


## MAIN TASKS OF BY-SPACE ACTIVITY

- manufacturing Space vehicles for remote sensing of the Earth and perspective technologies for Space facilities creation;
- construction of ground infrastructure for Space information receiving, processing, distribution and Space vehicle control;
- development of information and Space technologies and systems and their introduction in different fields of social and economic activity;
- carrying out the scientific research and scientific and engineering works on creation of basic elements, systems and perspective technologies for Space equipment;
- creation of training and retraining systems and advanced training of staff involved in Space activity;
- forming the state policy in the field of Space activity.

## RELEVANT OBJECTIVES

- Development of scientific fundamentals, technologies and perspective instruments for carrying out complex investigations of Space and use of Space information
- Space Systems and Technologies
- Development of Belarusian Space System for Remote Sensing of Earth
- Perspective Belarusian Space Vehicles
- Ecological Monitoring, Hydro-Meteorological Observations and Assessment of Nature Use Efficiency
- Application of Space Information in Geodesy and Cartography
- Monitoring the Natural and Techno-genic Emergencies with the Use of Space Information
- Assessment of Actual Condition of Agricultural areas by Space Information Systems
- Creation of Professional Aerospace Education System
- Organization of Safety Support System for Information Space Technologies
- Application of Space Information in the interests of the Forestry



**SubProgramme 7, "The exploration and use of outer space for peaceful purposes" for the 2017-2020** in the framework of State Programme "High technologies and equipment" for 2017-2020, formed pursuant to the Order of the Prime Minister of the Republic of Belarus.

- Further development of the Belarusian Earth Remote Sensing System
- The development of navigation, geodetic and mapping activities based on space technologies
- Further creation and development of human resources, scientific and technological, organizational and legal support of space activities in the Republic of Belarus



- Development of student space research including development of university satellites and using experimental data from its for education
- Modernization of the education system (new and updated educational trade, branched)
- International cooperation
- Development and implementation of international youth projects for the implementation of scientific and educational space experiments
- Development of Internet and distant education technologies



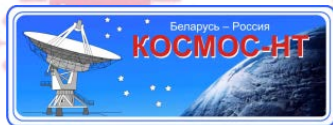
# Belarusian-Russian Space Programmes



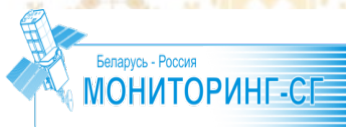
**The development and Implementation of Space Facilities and Technologies for Acquisition, Processing and Representation of Space Information» (Cosmos-BR) 1999-2002**



**The Development and Implementation of Perspective Space Facilities and Technologies in the Interests of Union State Technical Prosperity (Cosmos-SG) 2004-2007**



**The Development of Basic Elements and Technologies for Building and Implementation of Orbital and Ground Based Facilities of Multi-functional Space System» (Cosmos-NT) 2008-2011**



**The Development of Space and Ground Based facilities to Provide the Users in Belarus and Russia with Monitoring Results (Monitoring -SG) 2013-2017**



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# Other Belarusian-Russian Space Programmes

- **Development of Nanotechnologies for the Creation of Materials, Devices and Systems for Space Technology and Their Adaptation to Other Technical Fields and Mass Production (Nanotechnology-SG) 2009-2012**
- **Development of an Integrated System for the Standardization of Space Technology, Created Within the Framework of the Programmes and Projects of the Union State (Standardization-SG) 2011-2014**
- **Development of Complex Technologies for Creating Materials, Devices and Key Elements of Space Vehicles and Advanced Products of Other Industries (Technology-SG) 2016-2020**
- **Development of the System of Hydrometeorological Security of the Union State for 2017-2021**





## Development of Complex Technologies for Creating Materials, Devices and Key Elements of Space Vehicles and Advanced Products of Other Industries

1. Development of technologies for creating new materials for space applications
2. Development of technologies for creating elements of energy supply systems, thermal control and control for small space vehicles, including using microsystems, nanomaterials and nanoelectronics
3. Development of technologies for creating elements of target equipment for small space vehicles, including those which are based on microsystem equipment, nanomaterials and nanodetectors



# Space Exhibitions in 2017: 2-nd Belarusian Scientists' Congress



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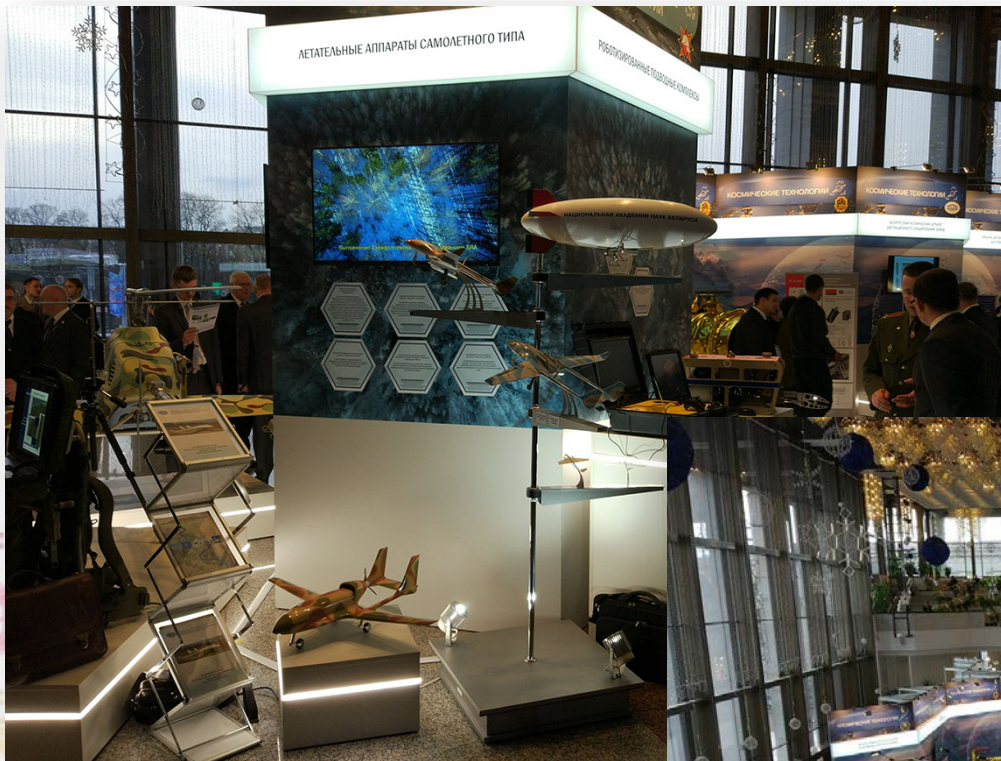
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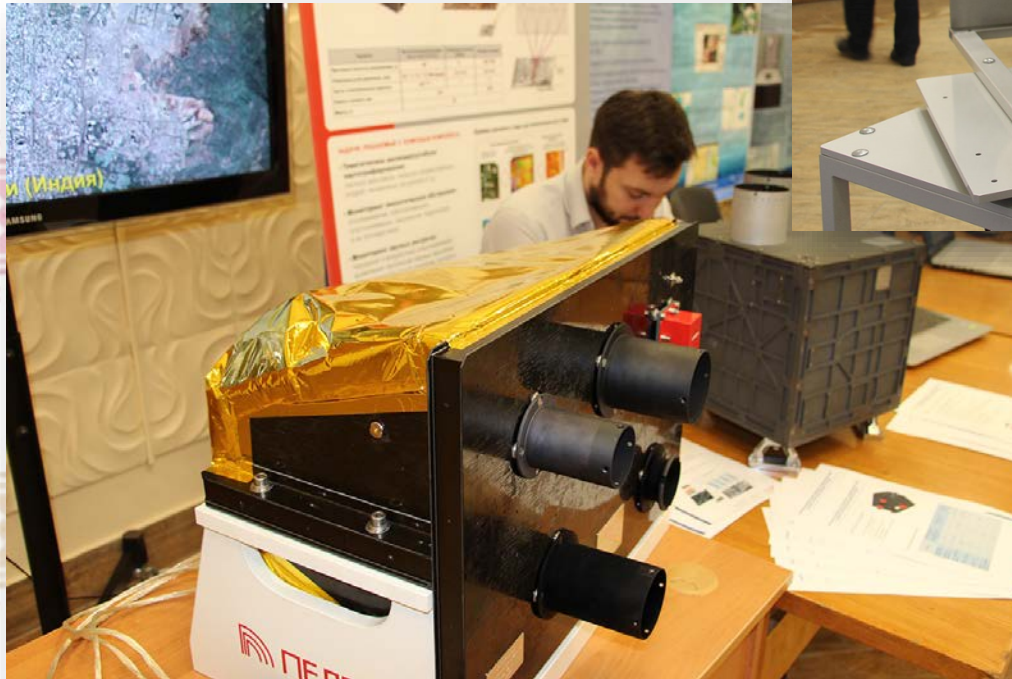
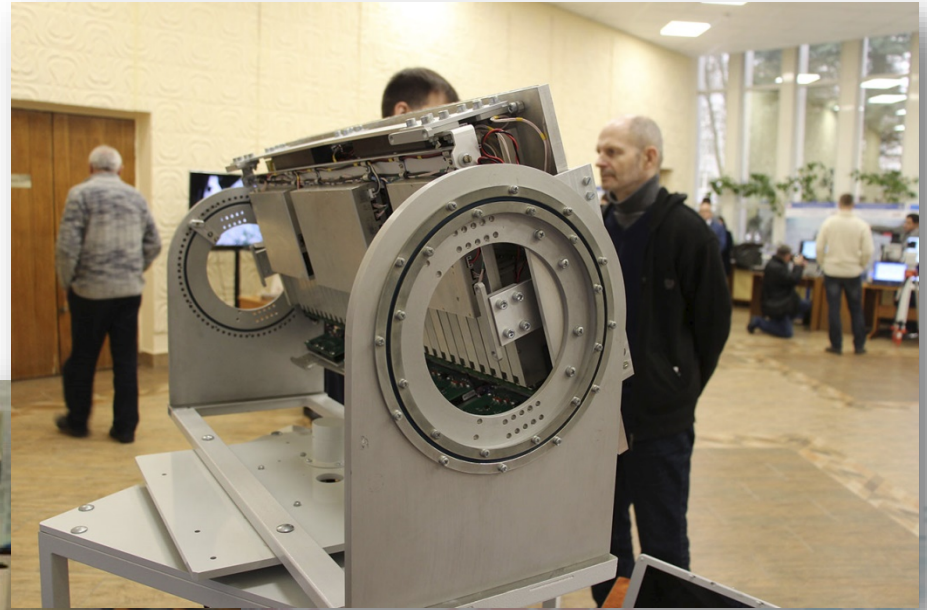
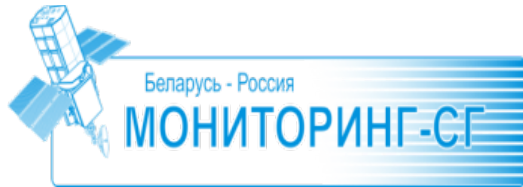


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# Space Exhibitions in 2017: MONITORING-SG

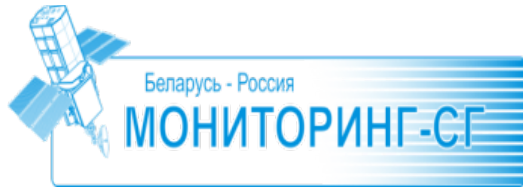


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# Space Exhibitions in 2017: MONITORING-SG



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## Air-based Video-spectral Systems



### Air-based System AVIS

- Aviation multispectral system AVIS of high spatial and spectral resolution has been developed by state scientific and technical program "Space Systems and Technology" as a part of multi-level system of aerospace monitoring. AVIS is designed to record multispectral and heat images of the Earth's surface in the time of aviation monitoring of areas of Belarus. State Client - National Academy of Sciences of Belarus.





## Space-based Video-spectral Systems



### Video spectral system VSS

- Designed to measure the characteristics of the reflected radiation of the underlying surfaces in the wavelength range from 400 to 950 nm on the service module (SM) of the Russian Segment (RS) of the International Space Station (ISS), while monitoring the earth's surface during scientific and applied research in the space experiment “Hurricane” (“Uragan”).



## Space-based Video-spectral Systems



### Photo spectral system VSS

- FSS is designed to measure the spectra of the reflected radiation of the underlying surfaces in the wavelength range from 350 to 1050 nm

and photo images in the visible wavelength range on the Russian segment of the International Space Station (ISS RS) in the space experiment “Hurricane” (“Uragan”)

Experimental basement - a system for monitoring and forecasting the development of natural and man-made disasters.

## Space-based Video-spectral Systems



### Spectral Photo-metric Complex

- The SFC is designed to study the spatial-temporal and spectral characteristics of optical glows of the upper

layers of the Earth's atmosphere from the side of the multipurpose laboratory module of the Russian Segment of the International Space Station with the aim of developing an empirical model of the mesosphere for predicting geophysical catastrophes (Space Experiment "Hydroxyl").

## Space-based Video-spectral Systems



### Video-photo-spectral system

- The VFS-3M is designed for automatic remote detection of optical radiation in the atmosphere and ionosphere of the Earth associated with thunderstorm activity and seismic processes in the 390-900 nm spectral region from the side of manned and unmanned vehicles, in particular, the Russian segment of the International Space Station.

## Satellite Payloads and Subsystems



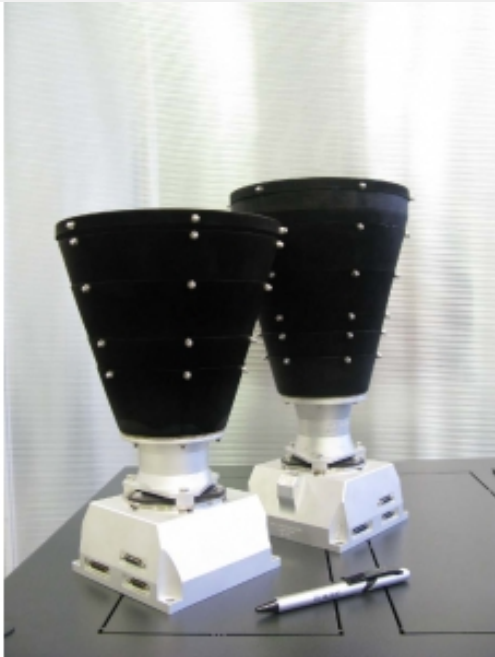
### Imaging Payload with 2 m GSD

Remote Earth sensing in visible band, and acquisition of current satellite imagery

#### *PAYLOAD DESCRIPTION*

- panchromatic camera (PC);
- multispectral camera (MC);
- onboard computer (OBC).
- snapshot imaging technology for high-resolution EO payloads provides superior geometric quality of the acquired imagery;
- coverage rate - 500 000 km<sup>2</sup>/day.

## Satellite Payloads and Subsystems



### Star Trackers

Operation in payload or satellite attitude control system.

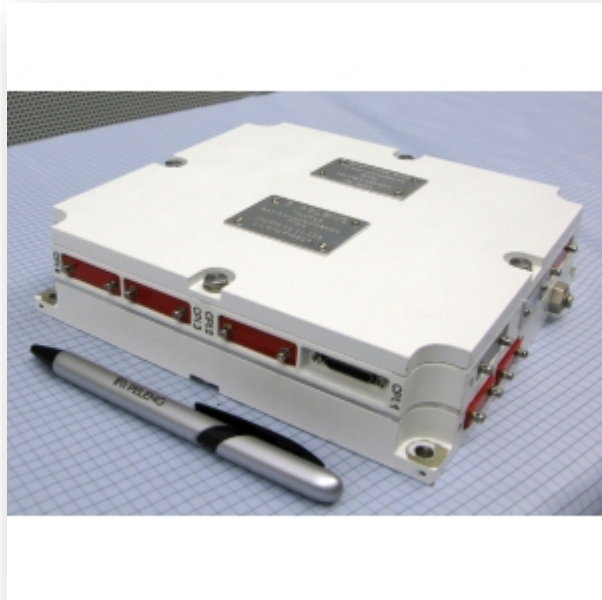
#### DETAILS

- CMOS sensor based autonomous star trackers with integrated angular speed measurement module.

#### STAR TRACKER SUBSYSTEMS

- electronic unit;
- lens telescope;
- aligner ring;
- baffle;
- software;
- package and cable set.

## Satellite Payloads and Subsystems



### Control and Synchronization Unit

Star tracker control and data exchange with satellite onboard systems.

#### SPECIFICATION

- Overall dimensions, mm 200 x 186 x 50
- Mass, kg , max 2,6
- Nominal power supply voltage, V 27, 12\*, 42\*, 100\*
- Nominal power consumption, W 12
- Command and data interface MIL-STD-1553B, RS422\*, CAN\*
- Timing (synchronization) interface
- Nonvolatile storage capacity, Gb 8, 0\*, 16\*, 24\*



## Satellite Payloads and Subsystems



### Attitude Determination System

#### ATTITUDE DETERMINATION SYSTEM COMPONENTS:

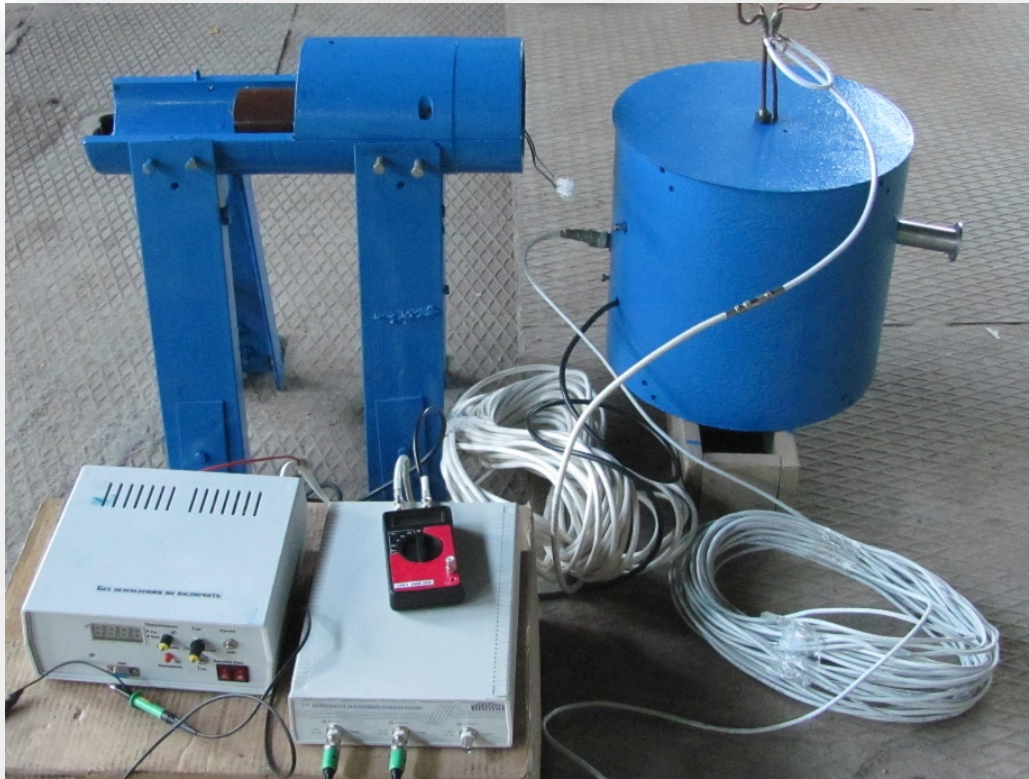
- Control and synchronization unit (CSU), pcs. 1 or 2
- Star tracker (ST), pcs. 2 to 4

#### ONBOARD UNIT PLACEMENT REQUIREMENTS

- Star trackers should be mounted on a thermally-stabilized common framework.
- ST to CSU maximal cable length - 3 meters.
- The Sun should be off the FOV of minimum two STs in any operation mode orientation.

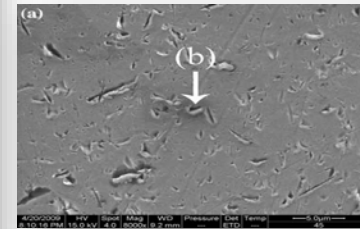


# Experimental System for Simulation and Recording of High-frequency Pulsed Electromagnetic Radiation, Simulating the Conditions of Interaction of High-speed Flows of Space Dust Micro-particles With the Spacecraft in Near-Earth Space Environment

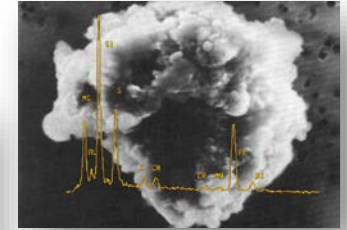


Experimental system for simulation and recording of high-frequency pulsed electromagnetic radiation

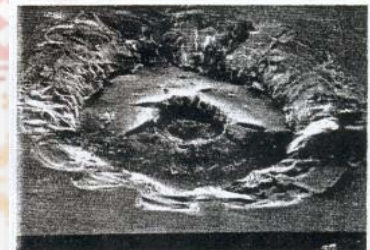
## SOLAR PANELS AFTER THE IMPACT OF COSMIC DUST



Micro X-ray spectral analysis of the micro-particles of cosmic dust

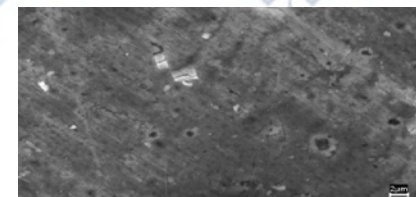
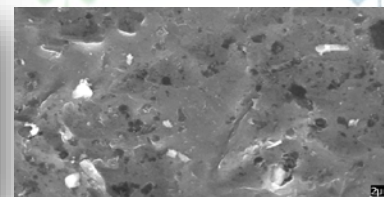
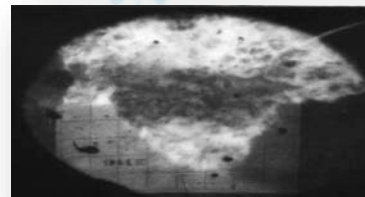


The surface of the Hubble Space Telescope solar battery



Micro crater 1,8 mm

## Micro craters on a model of an aluminum sample after exposure by micro-particles <100 microns, LABORATORY TESTS



# Methods and Experimental Equipment for Thermoelectric and Magnetodynamic Control of Technological Coatings With Space Purposes

**Purpose:** tool control of the thickness of nickel and chromium-nickel coatings in the technological process of production of rocket engines

**Structure:**

- Thermoelectric thickness gauge for measuring the thickness of nickel coatings, regardless of the magnetic properties of steel substrates;
- magnetodynamic thickness gauge MTNP-1 to measure thickness of nickel coatings;
- Magnetodynamic thickness gauge MTDP-1 to measure thickness of two-layer chromium-nickel coatings.



Magnetic thickness gauge MTDP-1

**Requirements to thermoelectric thickness gauge :**

- measurement range - (0 - 100)  $\mu\text{m}$ ;
- resolving power when measuring thermoEMF - not worse than 0.1  $\mu\text{V}$ .
- the main permissible error in measuring the thickness of coatings - within  $\pm (2 \mu\text{m} + 5\%$  of the measured thickness);
- the temperature difference between the hot electrode and the product - in the range from 29.5 to 30.5  $^{\circ}\text{C}$ .
- availability of memory for storing up to 100 calibration dependencies, incl. when the thickness gauge is turned off.

**Requirements to magnetodynamic thickness gauge MTNP-1 :**

- measuring range is (0 - 700)  $\mu\text{m}$ ;
- basic permissible error is within  $\pm (1.5 \mu\text{m} + 3 \cdot\%$  of the measured thickness);
- method of demagnetization - a pulse bipolar during measuring the thickness of nickel coatings;
- supply voltage of the system must not be more than 9 V;

**Requirements to magnetodynamic thickness gauge MTDP-1 :**

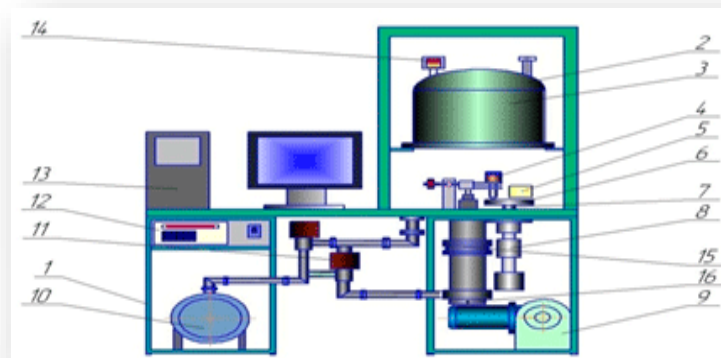
- the range of measurements of chromium coatings on nickel coatings at a thickness of nickel coatings from 200 to 700  $\mu\text{m}$  - (0 - 150)  $\mu\text{m}$ ;
- the range of measurement of nickel coatings under chrome with a thickness of chrome coatings is not more than 150  $\mu\text{m}$  - (0 - 700)  $\mu\text{m}$
- basic permissible error:

A) when measuring the thickness of chromium coatings on nickel - within  $\pm 5 \mu\text{m} + 5\%$  of the measured thickness;

B) when measuring the thickness of nickel coatings under chrome - within  $\pm (1.5 \mu\text{m} + 10 \cdot\%$  of the measured thickness).

# Novel Tribotechnical Materials with Improved Characteristics for Use in Outer Space and Equipment for Studying the Friction and Wear Processes of Tribotechnical Materials, Thin Films And Modified Surfaces Under Conditions Simulating Outer Space

## INSTALLATION FOR STUDYING FRICTION PROCESSES IN VACUUM



1. The table
2. The valve of admission of atmospheric air
3. Vacuum chamber
4. The loading mechanism of the indenter
5. The device for vacuum heating of the indenter
6. The mechanism for rotating of the test sample
7. The mechanism for lifting of indenter
8. The mechanism for determining the torque
9. Mechanism for lifting the vacuum chamber
10. Oil-free spiral pump Anest lwata
11. Electromagnetic valve
12. Controller of the Turbomolecular Pump
13. Personal computer
14. The wide-band module Micro-Ion Plus
15. Shutter Vacuum GVB-SS-CF100M
16. Shimadzu turbomolecular pump

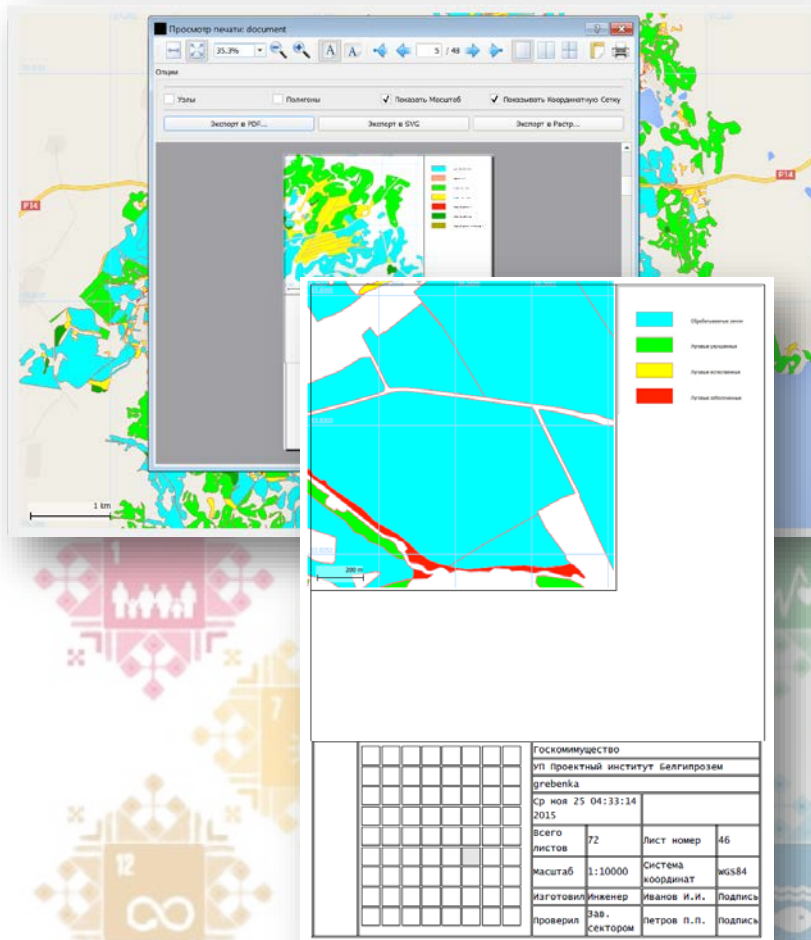


The cage of the experimental sample for the installation to study the processes of friction with a vacuum chamber and the mechanism for input of rotation

Technological equipment for the synthesis and sintering of samples with cylindrical shape.

Samples are made from composite super-hard materials based on CBN for the manufacture of rolling bodies for bearing units for space technology

# Experimental Software System for Operation Monitoring of Operative Remote Monitoring of the State of Agricultural Crops Using Data From Prospective Hyperspectral and Existing Aerospace Equipment

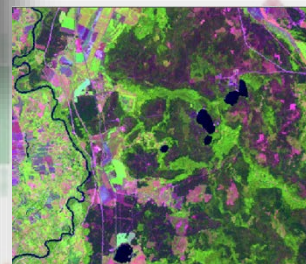


Generating of subject digital map and print preview

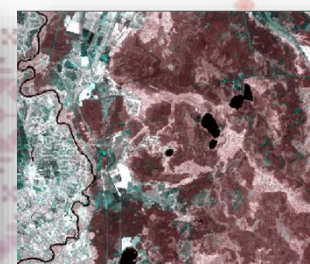
## Purpose:

- Development of technology for Remote Sensing data application for operational remote monitoring of agricultural land condition;
- Improvement of methods and algorithms for processing Remote Sensing data to increase the degree of automation of the processes of allocation and classification of agricultural lands

## INTERPRETATION OF LANDS



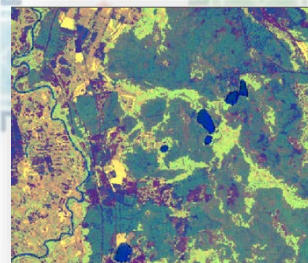
Initial image with pseudo-colors



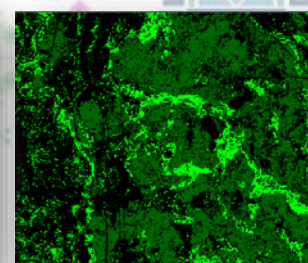
Selection of most informative channels



RGB - IHS transformation



Clusterization (segmentation) of HIS-image



Subject Information Extraction

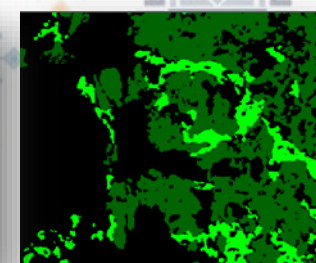
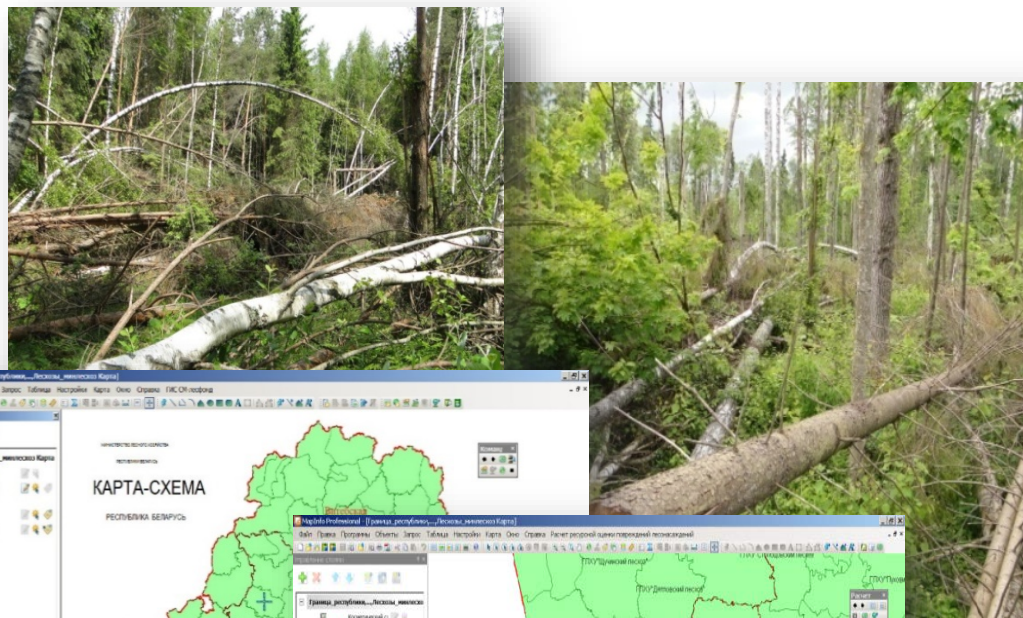
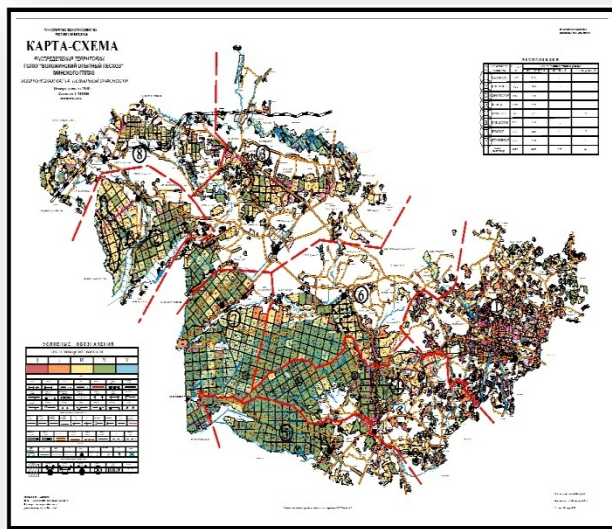
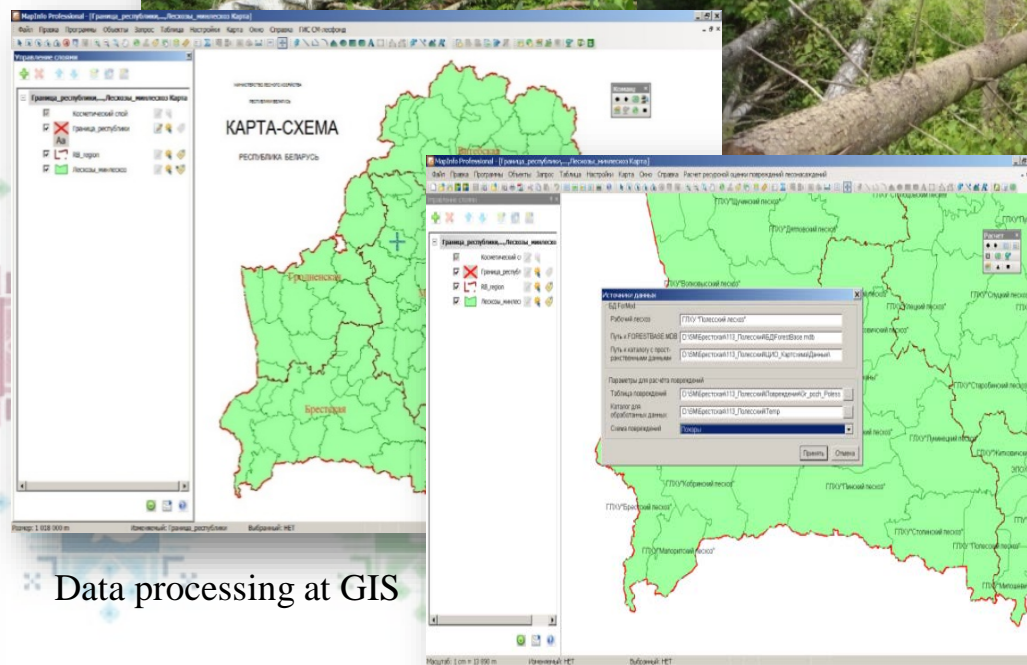
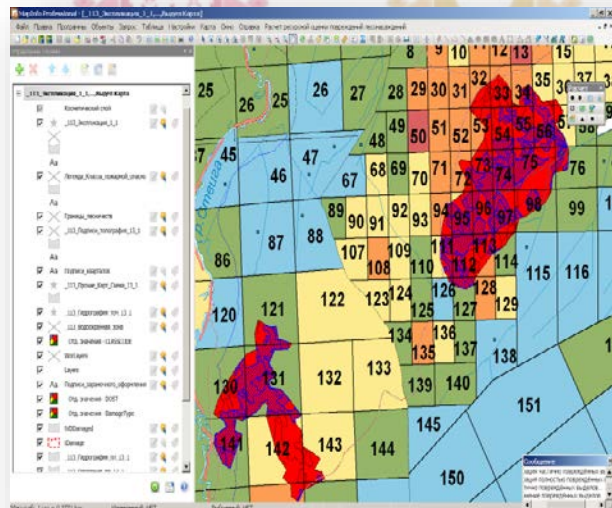


Image Generalisation

# Geo-Information System for Integrated Monitoring of Forest Resources, Forest Exploitation and Fire Hazard Assessment Based on Forest Regulation, Radar and Multispectral High-resolution Space Imagery



Fire hazard mapping



Data processing at GIS

Drawing of boundaries of damages of forest resources

# Experimental Integrated System of Coordinated Satellite and Terrestrial Remote Observations of Hazardous Emissions Into the Atmosphere and Control of Large-scale Pollution Transfer

Hardware complex for integrated lidar and radiometric measurements

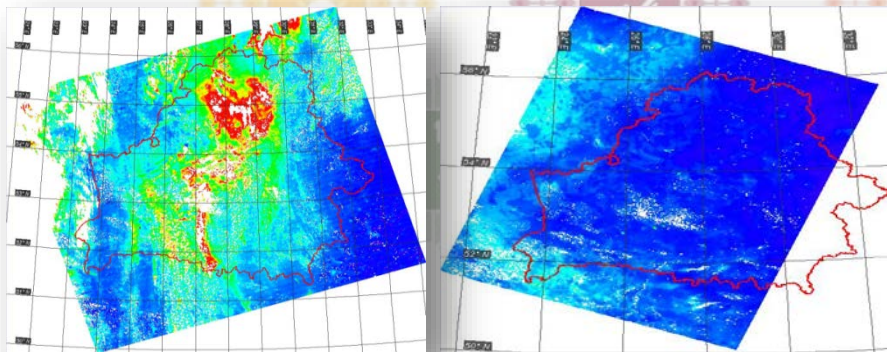


a) multiwave polarization Raman lidar MSTL-2

b) model of multiwave lidar "COSMOS-NT";

c) Solar multi-wavelength scanning radiometer CE-318N-EB9

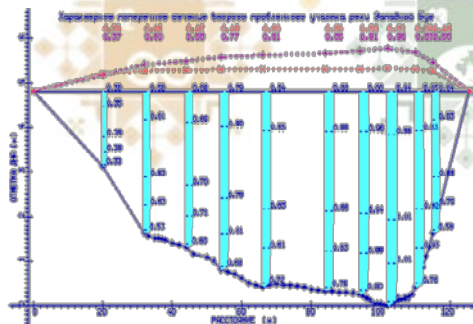
Distribution of aerosol optical thickness of the atmosphere on the territory of Belarus. It has been transferred to **National Environmental Monitoring System**



# Experimental Technology and Software For Bed-movement Monitoring and Hydrological Regime of Rivers Using Remote Sensing Data



Scheme of the location of the problem area No. 2 of the Western Bug River, taking into account the recommended strengthening of the right bank



Calculated local longitudinal averaged water flow velocities, averages on verticals and allowed (non-smashing) water flow velocities in cross sections of two problem areas of the Western Bug River. Water discharge is close to the channel-forming regime



Strengthening of the shore with a stone outline on the layer by rubble on the geotextile canvas, or with flexible concrete mats using concrete composite slabs with flexible connections.

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United Nations  
Office of Outer Space Affairs

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