ЦНИИМАШ
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ROSCOSMOS

OVERVIEW OF THE ISS RUSSIAN SEGMENT RESEARCH AND FACILITIES

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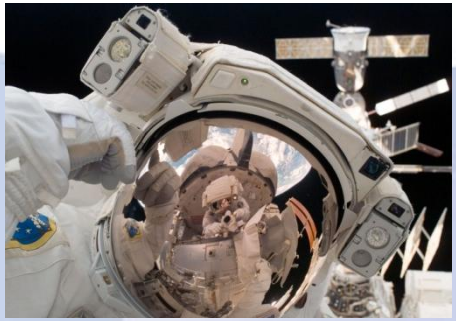
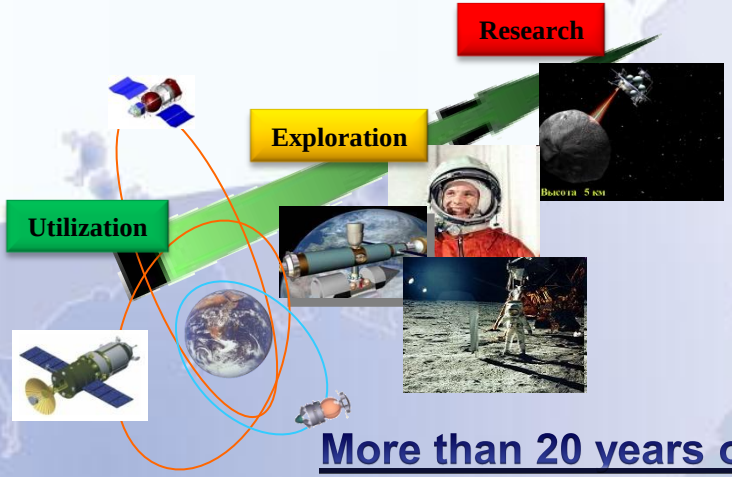
Russian Federal Space Agency
(Roscosmos)

UN-HSTI ISS Outreach Seminar
Vienna, 2011

International Space Station (ISS)

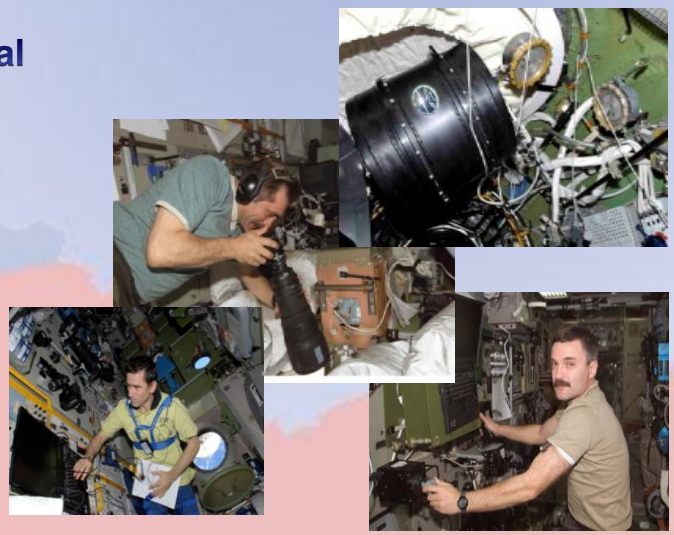
ISS is important phase of human space exploration



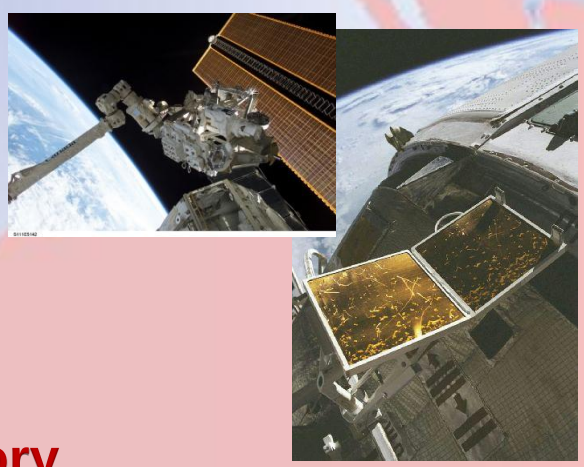


More than 20 years of PERMANENT human residence in space

Demonstration of international cooperation capabilities

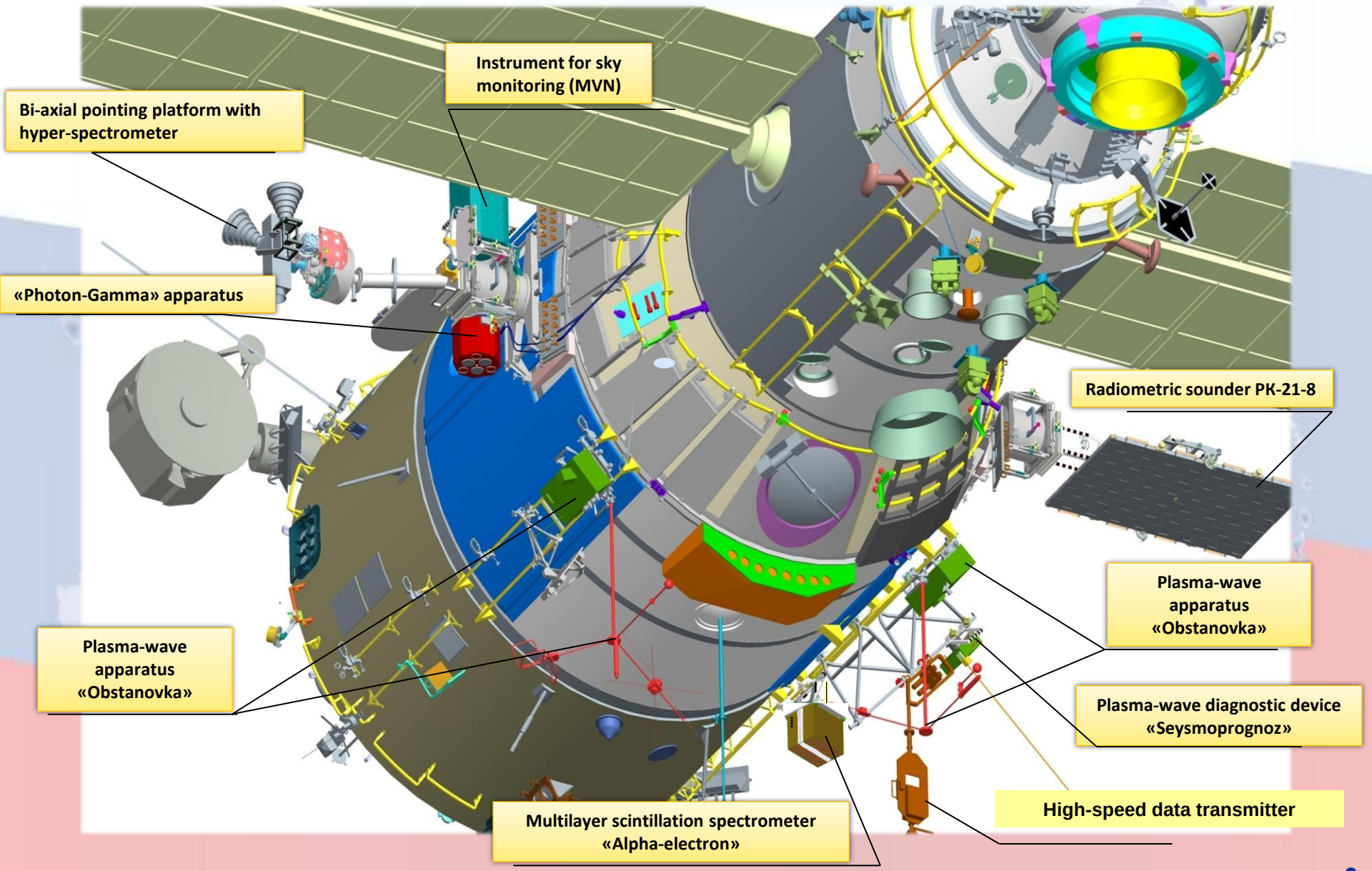


Advanced technology maturation

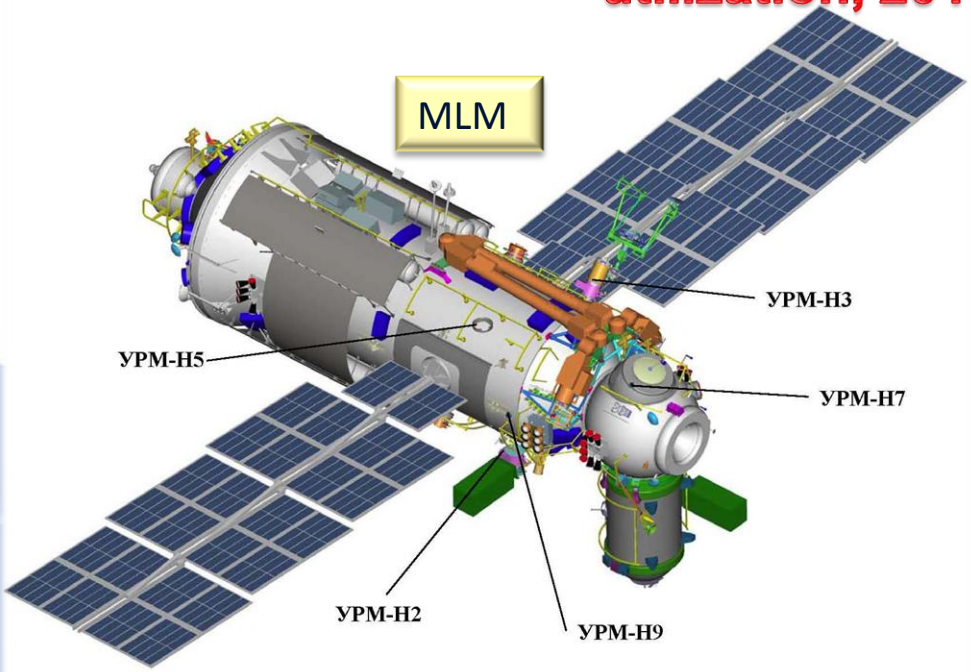


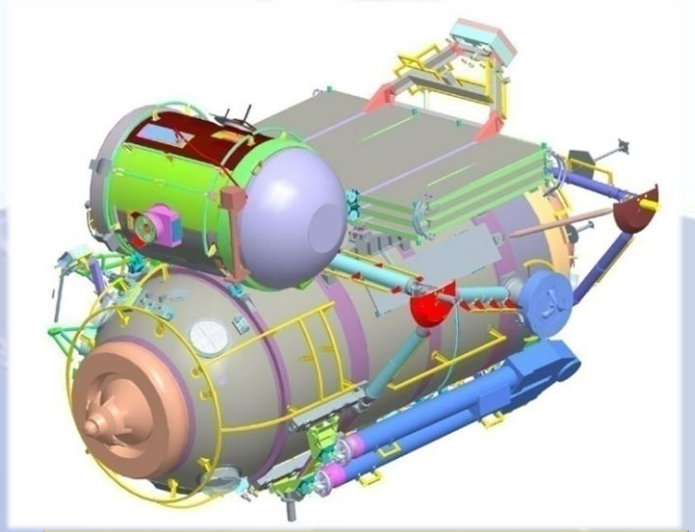
Unique scientific laboratory

Completion of the ISS development – beginning of full-scale utilization, 2010



Completion of the ISS development – beginning of full-scale utilization, 2011-2014



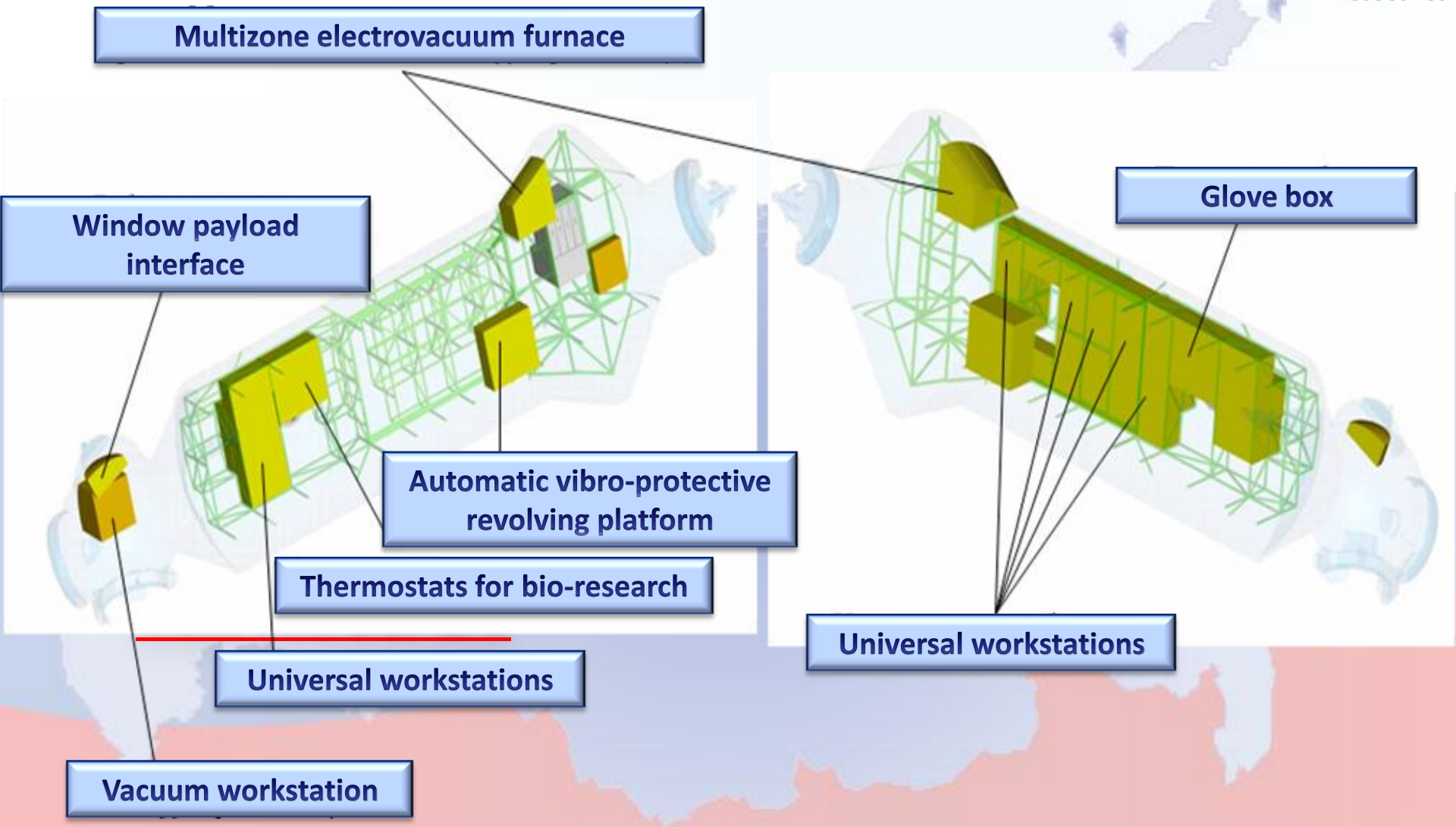


Mini Research Module (MRM1)

- Universal workstations inside (16) and outside (13) will be mounted
- Payload pressurized volume about 6 м^3, power capability of 2,5 kW (enabling of experiments with electric furnaces)
- ERA arm and automated airlock
- New universal facilities and tools (multizone furnace, spectrophotometers, vibro-protecting and pointing platforms, glove box, thermostats etc.)

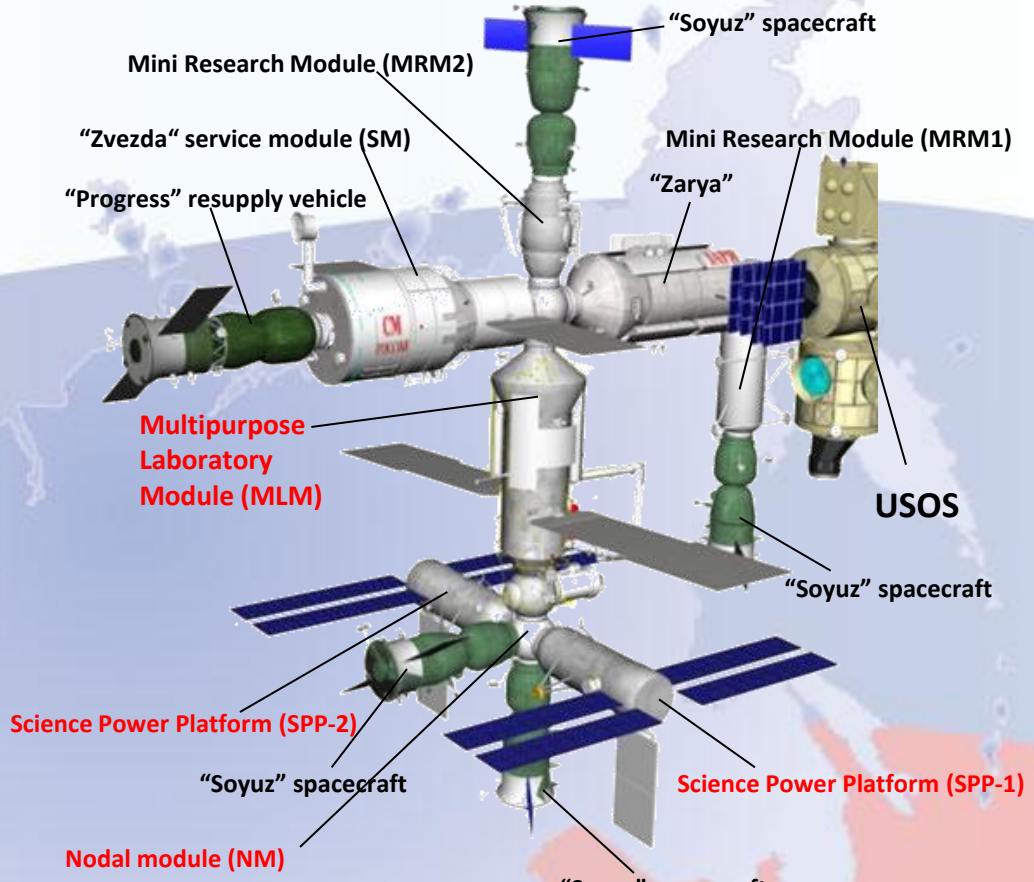
Mini Research Module (MRM2)

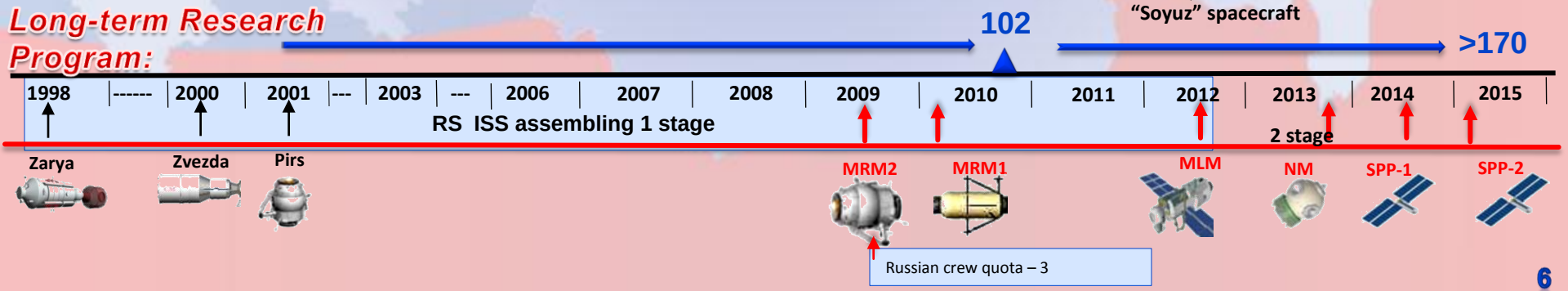
MLM payloads



Future research capabilities of the RS ISS

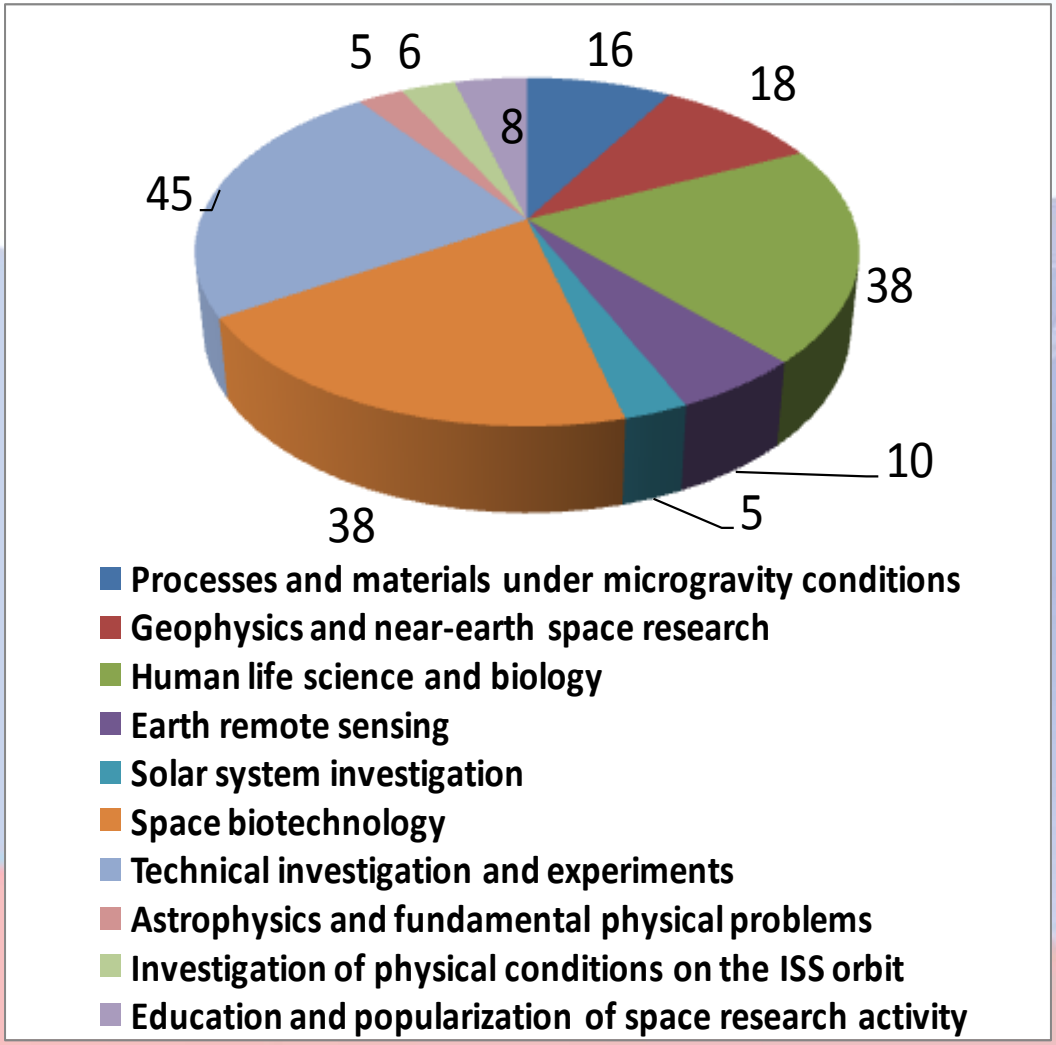
- MLM will support approximately 40% of the total amount of experiment planned for the ISS RS
- Two scientific and power supply modules of about 15 kW each by 2015. This provides fully independent power supply of RS ISS
- Data relay system based on «Luch» relay satellites (up to 300 Mbps).
- Starting from 2016 Russia plans also to use for experiments automatic spacecraft “OKA-T” maintained at the periodical docking with ISS.
- In total, the plans call for 8 modules of the ISS RS by 2015, with total power capability of 30 kW and the payload pressurized volume about 40 cubic meters.





The ISS utilization in Russia

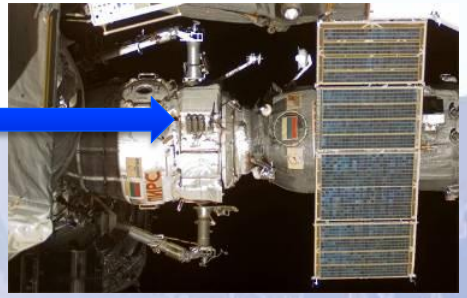
Long term research program

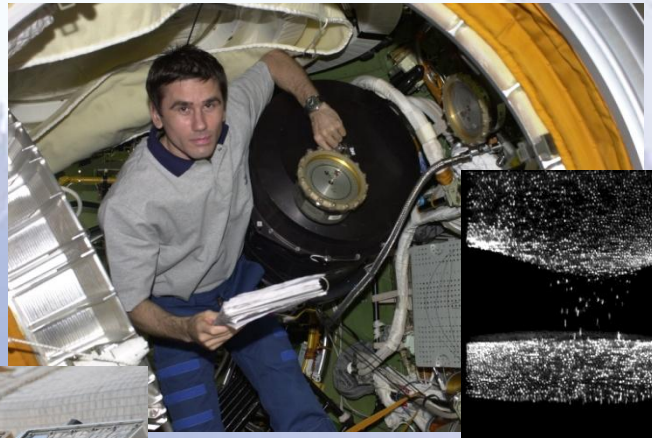


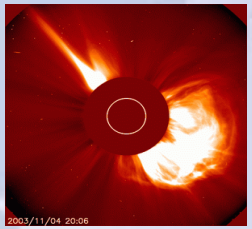
- About 130 unites of scientific equipment of about ton total mass are housed on the ISS RS.
- Hundreds of scientists are involved in the scientific program from more than 40 organizations.
- Much more room will be available in the next few years for additional experiments
- 103 Russian space experiments were conducted by 2011.
- 39 space experiments are completed (>6,000 scientific sessions).
- 64 experiments are carrying out, 86 experiments are being prepared;
- Results were presented in more than 650 scientific articles and reports;

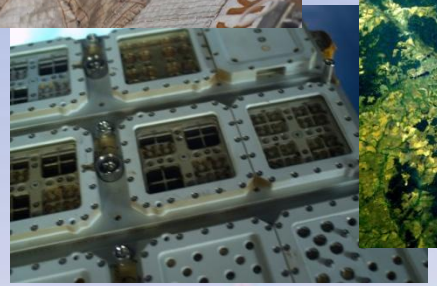
Areas of the research results implementation

Fundamental sciences

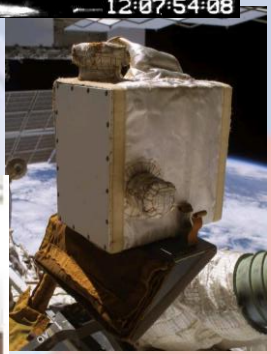








Applied sciences

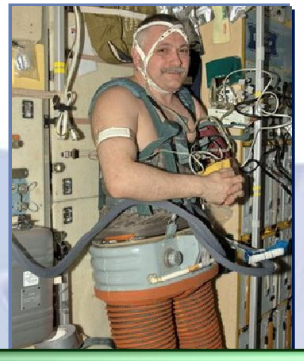


Future exploration technologies

Biomedicine

- Health care in the long flights on the ISS, experiments for future flights to the other planets.
- Study of mechanisms of biological adaptation to space flight conditions (weightlessness, radiation, artificial habitat).

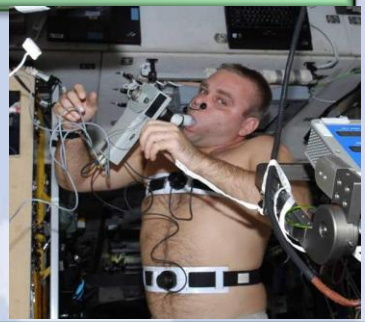
30 experiments were implemented



Weightlessness countermeasures

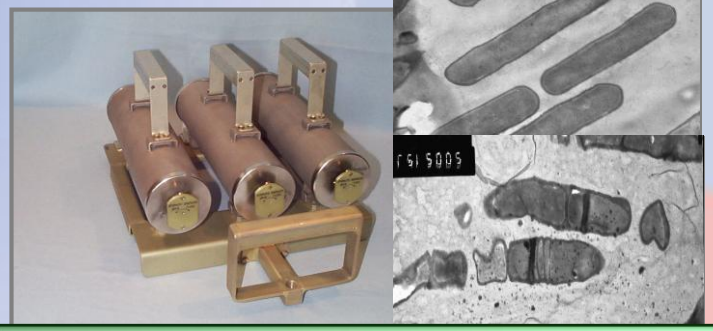
Pilot-M: Study of psychophysiological state of cosmonaut-operator

Plant biology



M.Suraev conducts Dykhanie experiment

Matroshka: study of radiation environment with different phantoms in- and outside ISS

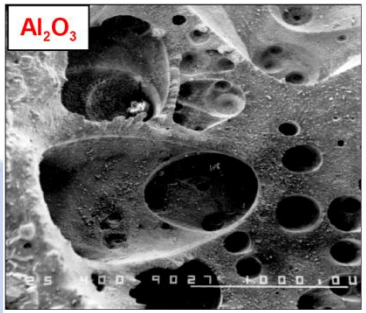


Biorisk: Study of microbiological risks. Some bacterial and fungi strains can survive for 2 years in open space.

- Some results of these medical research are also applicable in clinical practice on Earth.
- The future missions to the Moon and Mars will be much more difficult and fully autonomous which requires even increasing safety and efficiency of medical care.

Physical and chemical processes at the Reduced gravity condition

- Crystal growth, new materials and structures, physics of burning and synthesis, liquids, phase transitions, low temperatures under reduced gravity conditions: **5** research programs were implemented



SHS: Self propagating High-temperature synthesis of different high-melting inorganic materials. Results can be used for repair works in space and building on other planets

Crystallizator: High quality protein crystals growth.

Nonlinear waves in plasma crystal

Multizone furnace MEP-01

For the next decade:

- High quality crystals growth semiconductors, metals and dielectrics by different methods with multizone furnace:
- Fluid and transport physics, low temperatures:
- **«Ekran-M»** experiment: Synthesis of semiconductor multilayer heterostructures in space vacuum ($p<10^{-12}$ mm Hg) by Molecular Beam Epitaxy technology behind the molecular shield could improve nano-electronics, in particular raising the efficiency of solar cells as much as 60%.

Ekran-M

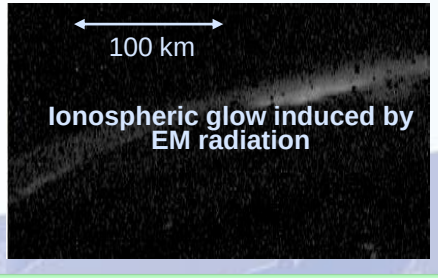
Geophysics

- Study of geophysical processes from outer space, including the processes in the upper atmosphere and near-Earth space environment

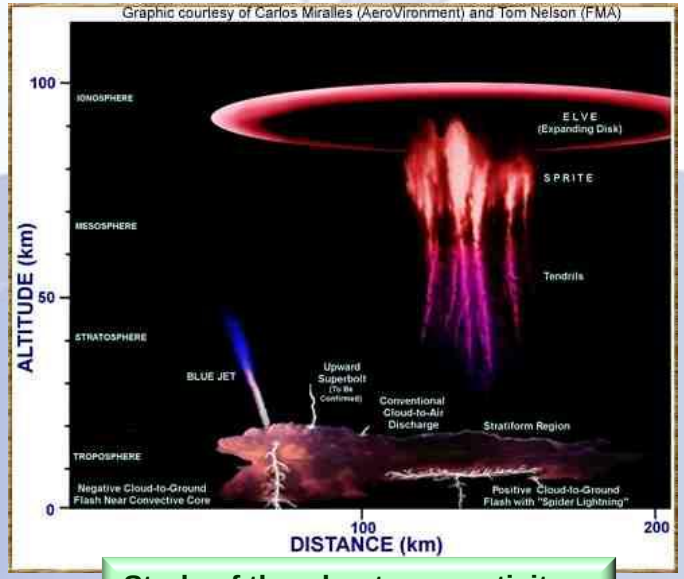
8 research programs were implemented

Vsplesk facility preparation (Inc.#17)

Experiment Vsplesk: development of earthquake forecasting methods with the precursor-bursts of high-energy charged particles in the near-Earth space



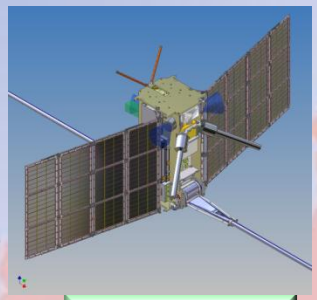
Experiment Relaxation: Study of atmospheric optical phenomena on the orbital altitudes



Study of thunderstorms activity

For next decade:

- physics of atmosphere and ionosphere
- plasma physics and space weather effects
- study of disaster (earthquakes, climate change etc.) forecasting methods and precursors



Microsputnik Chibis

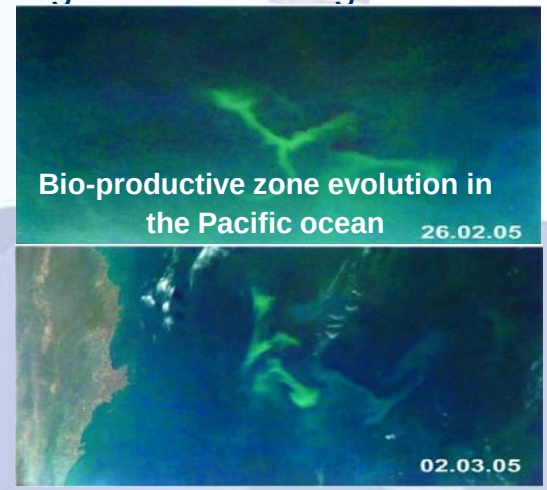
Outer detectors of Photon-Gamma apparatus in the thermo vacuum test chamber

Earth remote sensing

- New methods and tools for the Earth observation and ecological monitoring from space.

5 research programs were implemented

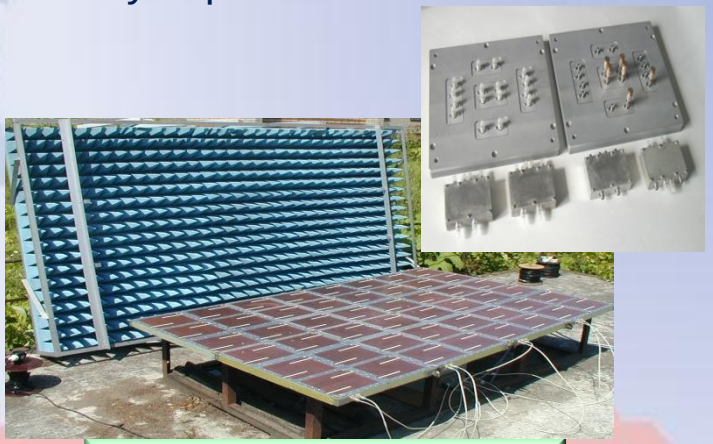
- Monitoring of ocean bioproductivity for research and fishing needs.



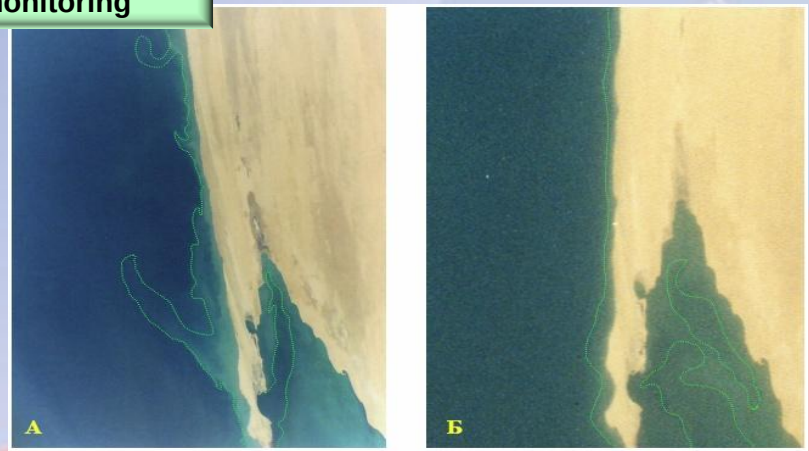
Glacier monitoring

For next decade:

- Optical study of the atmosphere – land and ocean system.
- Radiometry experiments



8 – channel microwave radiometer
(λ = 21 cm)



Geographical location and shape of high-productive water area of Canary upwelling in intensification 06.01.2008 г.(А) and relaxation 12.06.2005 г.(Б) periods.

Biotechnology

- Study of the biological and biotechnological processes in space, development of basic technologies for manufacturing of bio-products under microgravity conditions.

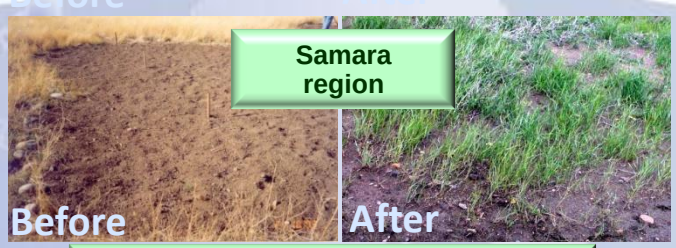
24 experiments were implemented

- Search for AIDS, Hepatitis-B vaccine, anticancer drugs
- Diagnostic systems and immunomodulators
- Fungi strains: remedies and stimulators of plant growth
- The effective bacterial forms for oil biodegradation

For next decade:

- Study of influence of space conditions on the cultivated strains, cells and intercellular environment.
- Development of bioreactors, biospecific sorbents, methods and tools for bioproduct detection and other equipment for various strain cultivation and bioproducing.
- And much more investigation for next generation medicine (vaccines, drugs and strains).

Moscow region



Samara region

Recultivation of oil polluted parcels of land (2007 – 2008)

Glove box use in Aseptic experiment

Hybridizator Recomb-K

Thermostat-container "AQUA-01"

Space technologies

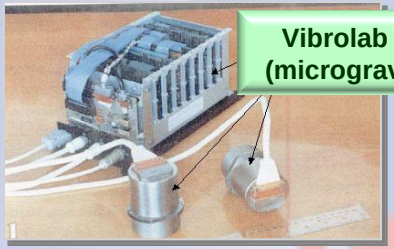
- The development of space technique, technologies, energy systems and their application to the research on ISS RS and for further space exploration.
- Study of physical conditions in the ISS orbit and its impact on the safety of the crew, space equipment and materials.

26 experiments were implemented

Leaks finding with special pointer

Corrosion of aluminum alloy under combined action of ultrasound and water condensate (x 200)

Veterok devises on board of ISS RS (air parameters control)



Vibrolab apparatus (microgravity control)

For next decade:

- Increase the efficiency and safety of space exploration, ISS resource prolongation. New methods and technologies to find leaks, disruptions, corrosion points, protection against radiation and other negative factors of space.
- Development of new technologies for preservation of Earth's ecosystem, by removing from the surface those power-consuming and waste-producing industries, in particular energy generation industry, for instance:
- **Znamya** experiments – testing of large-scale thin-film construction deployment in space
- Automation and robotization of the space activity.
- Exploration systems

Znamya experiment

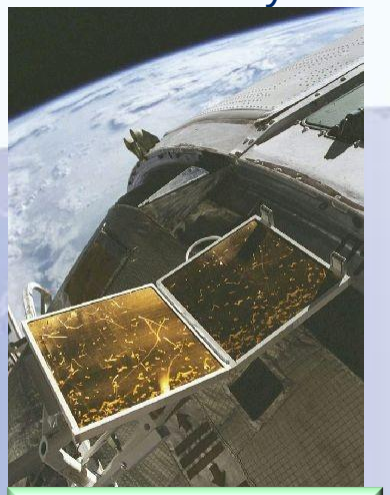
Solar system and astrophysics investigations

- Sun, planets and small bodies of the Solar system.
- Study of the interplanetary matter on board the ISS by contact methods (mass spectrometric, physical and chemical methods of analysis of near-Earth space dust).
- The structure of the Universe and processes outside the Solar system and associated fundamental physical problems.

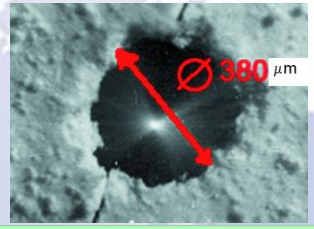
2 research programs were implemented

- **Platan** experiment: Study of iron group nuclei in galactic cosmic rays and ions in solar cosmic rays. Detection of micro-particles around the ISS.

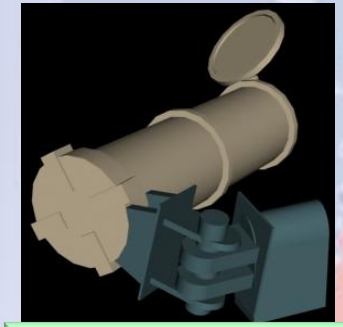
- **BTN-neutron** experiment: Studying of charged and neutral particles during Solar Particle Events; detecting of Gamma Ray Bursts "simultaneously" with HEND/Mars Odyssey for interplanetary triangulation;



PLATAN (PLAstic Track ANalyzer) – multilayer lavsan based detector



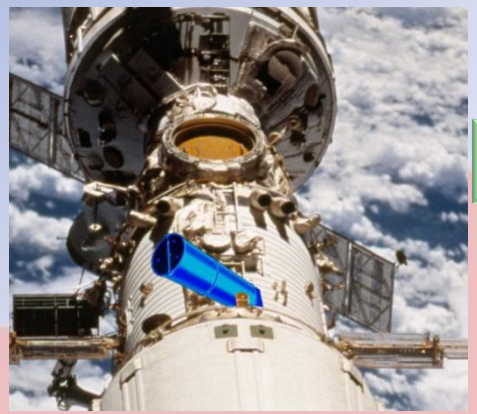
Hole caused by a debris particle
The number of such particles appears to be 2 times more than predicted



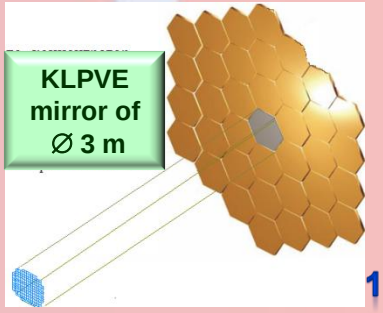
Telescope of Ø 600 mm for Planet monitoring

For next decade:

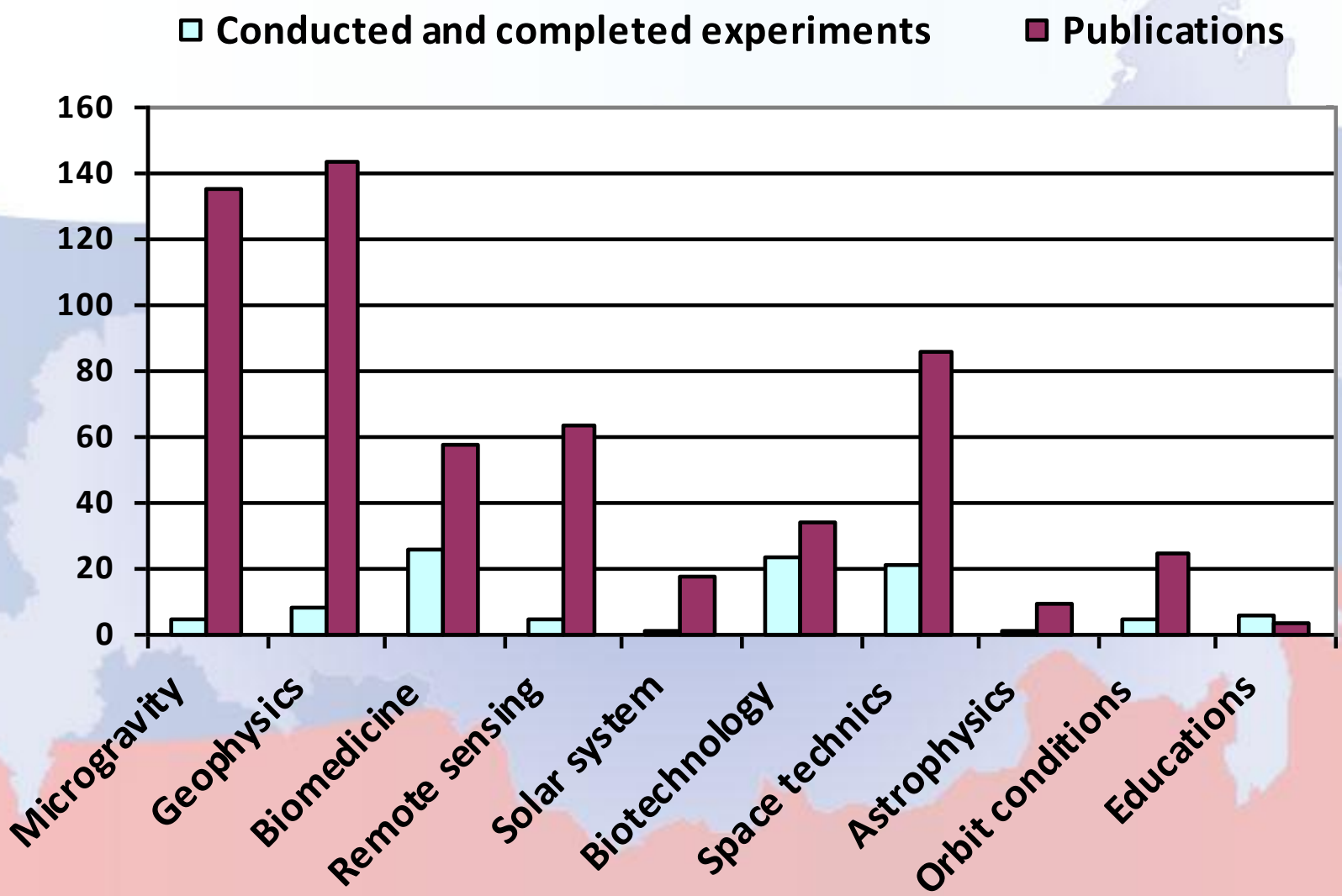
- Solar system investigations:
  - **Planet monitoring** (study of planet's surface, atmosphere, clouds; exoplanets, debris and asteroids)
  - **Dust and microparticle detector.**
- Astrophysical experiments:
  - **KLPVE** – study of ultra high energy particles $>10^{19}$eV
  - **MVN** – all the sky monitoring in X-rays
  - **Lira-B** – high precision photometrical and coordinate measurements



Future location of Lira-B telescope



Experiments and publications



The experiment results are stored in the Roscosmos data bank.

International cooperation

ESA

Upon the Frame Agreement signed
Joint Experimental Program is enforced

***In the* first line**

Plasma crystal
Matroshka
Relaxatsiya (ATV-reentry)
Dal'nost' (GTS-2)

In the second line

Bars (Lipidis)
Display (Pasta)
VIPIL
Peritektika (Parsec)
DSMIX
VILMA
… about 10 experiments

Dozens of experiments in future

JAXA

Russian *Crystallizer* experimental program has been joined with *PCG* experiments on Japan Protein Crystallization Research Facility

Scientific protocols of *Aquarium-AQH* and *Matroshka-P* experiments have been signed.

Investigation of Medaka fish in *Aquarium-AQH*

Matroshka-P - Padles

NSAU

The Program of Scientific & Applied Experiments has been updated in framework agreement between Roscosmos and State Space Agency of Ukraine.

CSA

One experiment is carried out, another is planned

NASA

Suggestions on possible areas of future scientific collaboration with NASA are being discussed

Conclusions

- International space station has become a symbol of intellectual potential of humanity.
- ISS is a unique space laboratory for conducting fundamental and applied research, preparation for the further exploration of the solar system.
- Fully utilizing of the ISS by international partners will give us many new exciting results.

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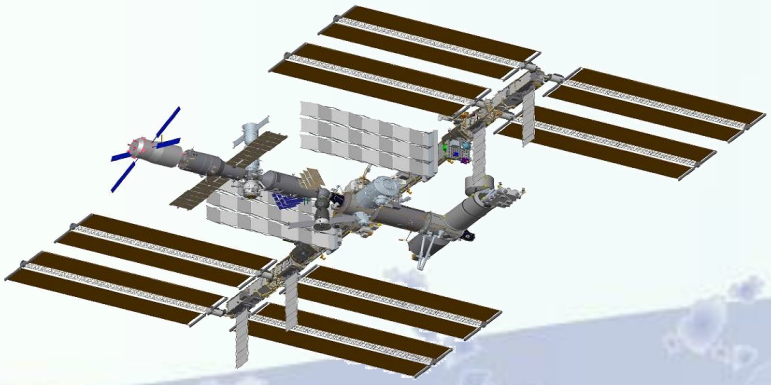

THANK YOU!