Russian Academy of Sciences

PERSPECTIVES OF THE RUSSIAN PROGRAM OF FUNDAMENTAL SPACE RESEARCH 2006 - 2015

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FUNDAMENTAL SPACE RESEARCH IN RUSSIA

- **The basis of space activity in Russia is founded by Fundamental Space Research (FSR), directed at the receipt of principle new knowledge about the Universe and its laws with use means of rocket-space technique and scientific apparatus, which is delivered by these means to space.**

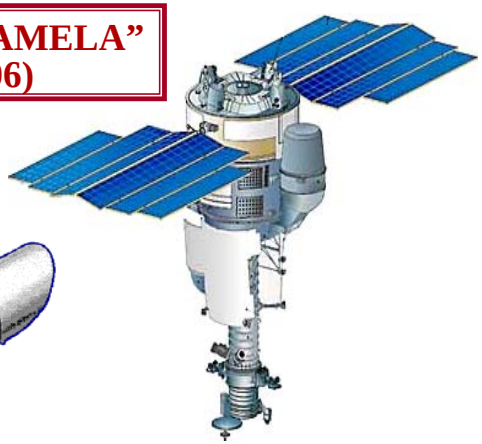
- **In the course of FSR development in the Russia (1957 – 2005 years) there were shaped the following 6 basic scientific directions:**

- **· Extra atmospheric astronomy and Space ray physics,**
- **·Studies of Planets and Small bodies of the Solar system,**
- **·Physics of Space plasma and solar-terrestrial interactions ,**
- **·Earth observations ,**
- **·Materials processing in space ,**
- **·Space biology and physiology .**

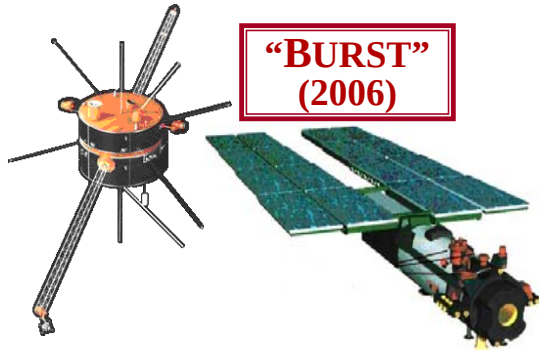
FUNDAMENTAL SPACE RESEARCH

PLANNED LAUNCH DATE OF THE MISSIONS IN 2006-2010

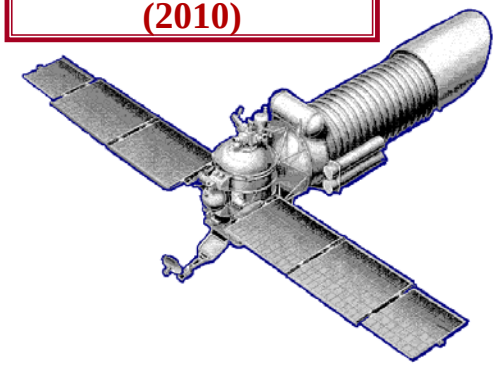
"RIM – PAMELA" (2006)



"BURST" (2006)

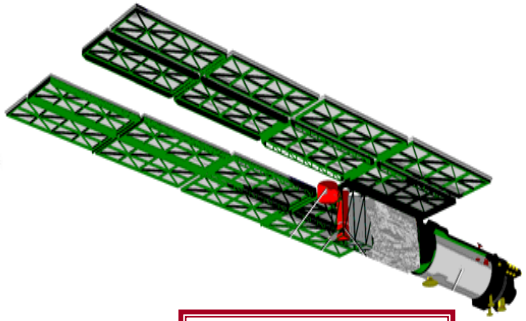


"SPECTRUM - UV" (2010)



"SPECTR - R" (2007)

"PHOBOS – SOIL" (2009)



"NUCLON" (2008)

"CORONAS - PHOTON" (2007)

PROJECT "RIM – PAMELA"
(russian-italian mission)

Goal Of The Project - Study in the near-Earth space of fluxes of antiparticles (antiprotons, positrons, light nucleus), electrons and isotope abundance in the primary cosmic rays.

Experiment "Rim – Pamela" will be an additional scientific payload for the spacecraft "Resurs 01". "Resurs 01" will be launched on a Sun-synchronized orbit with height 690 km and inclination 98.5°.

Payload mass is 470 kg together with the PAMELA instrument. The period of the active operation is 3 year.

The spacecraft launch is planned for 2006.

Leading scientific organizations: Moscow State Engineering-physical Institute (Russia) and State Institute of Nuclear Physics (Italia)

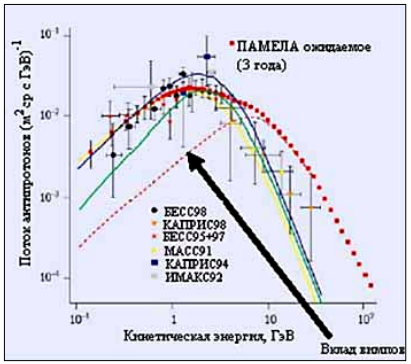
E-mail: galper@incos.mephi.ru

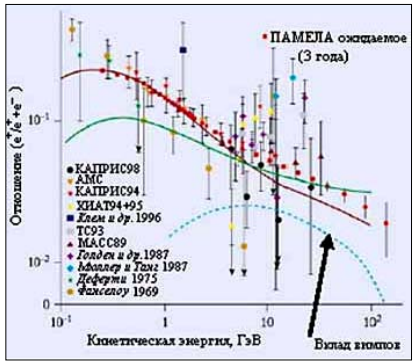
Russia

Italy

Sweden

Germany





MAGNET SPECTROMETER PAMELA

1,3,7,9- SCINTILLATION TIME OF FLIGHT SYSTEM;
2- TRANSITION RADIATION DETECTOR;
4- SCINTILLATION ANTICOINCIDENCE SYSTEM;
5- SILICON STRIP COORDINATE SYSTEM (SIX DOUBLE LAYERS);
6- MAGNET SYSTEM (FIVE SECTIONS);
8- SILICON STRIP IMAGING CALORIMETER;
10- WALLS OF THE VESSEL.

THE BURST PROJECT

(KONUS-WIND and KONUS-A experiments)

Goals Of The Project–

- detailed study of the time histories of gamma-ray bursts;
- study of the gamma-ray burst energy spectra over a wide energy range from 10 keV up to 10 MeV;
- study of the fast spectral variability of burst radiation both in the continuum and in features;
- localization of gamma-ray burst sources by two independent methods: by the autonomously localization system and by the triangulation method in cooperation with the IPN;
- search and investigation of an optical activity of the burst sources beginning from initial phase of the event registered in gamma-rays, significant refinement of localization at possible detection of an optical transient.

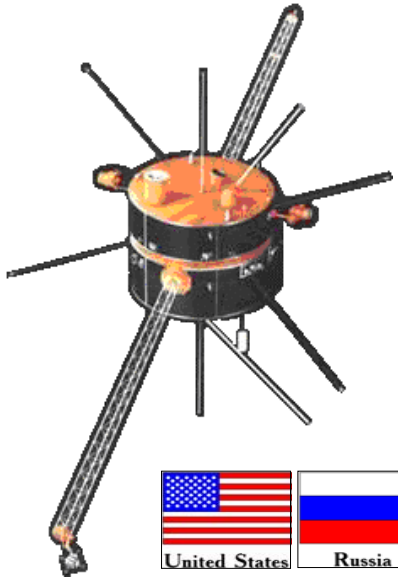
Leading organization for the KONUS-WIND and KONUS-A scientific instruments: A.F.Ioffe Physico-Technical Institute, Russian Academy of Sciences

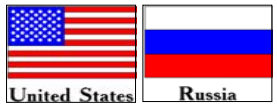
E-mail: mazets@mail.ioffe.ru

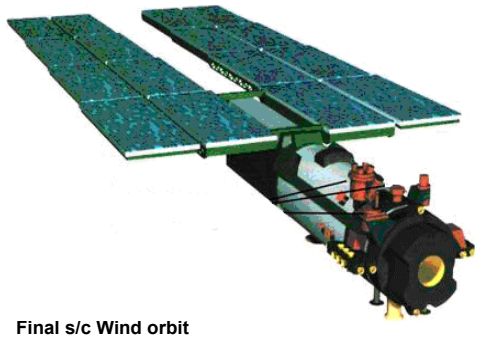
Leading organization for the E2U type spacecraft: M.V.Frunze Arsenal Design Bureau.

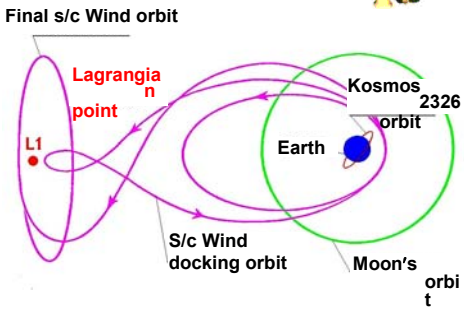
The joint Russian-American KONUS-WIND experiment is successfully being carried out at the American spacecraft “Wind” since November 1994.

The Planned date of the Russian apparatus launch is 2006









LIST OF SCIENTIFIC INSTRUMENTS

Konus-Wind instrument :

- Two spectrometric scintillation detectors with NaI(Tl) crystals, 130 mm in diameter, 76 mm in height, with beryllium entrance windows;
- Electronics unit for collecting and processing of detector signals and transmission of the information to the spacecraft telemetry system.

Konus-A instrument :

- System consisting of 3 spectrometric KONUS-A-DS scintillation detectors with NaI(TL) crystals 200 mm in diameter, 50 mm in height, with beryllium entrance windows and anizotropic diagram of angular sensitivity for the study of the temporal and spectral characteristics of bursts and autonomously localization of their sources;
- The KONUS-A-DO small optical telescope with CCD-matrix as the focal plane detector for the search and investigation of an optical activity in the burst sources simultaneously in gamma- and optical spectral ranges;
- The KONUS-A-BE electronics units for collecting and processing of detector signals and transmission of the information to the spacecraft telemetry system.

"SPECTR-R" (Mission "Radioastron")

Main scientific tasks of the mission –

syntheses of high-precision images of various Universe objects, its coordinates measurements and search their variability with the time. A beam width of the system is up to 35 microarcseconds (for spare orbit it is up to 10 microarcseconds)

Main characteristics of the space radiotelescope

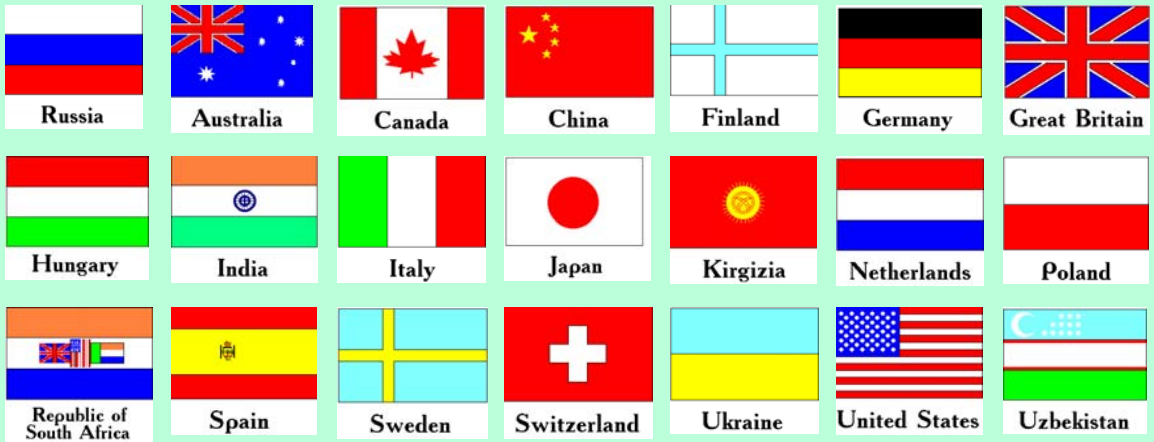
Spectral band:

- **wavelength (cm) - 92; 18; 6.2; 1.35**
- **frequency (Ghz) - 0.327; 1.66; 4.83; 22.2**

Main organizations:

on scientific complex - **Astro Space Center of Lebedev Physical Institute of Russian Academy of Science;**

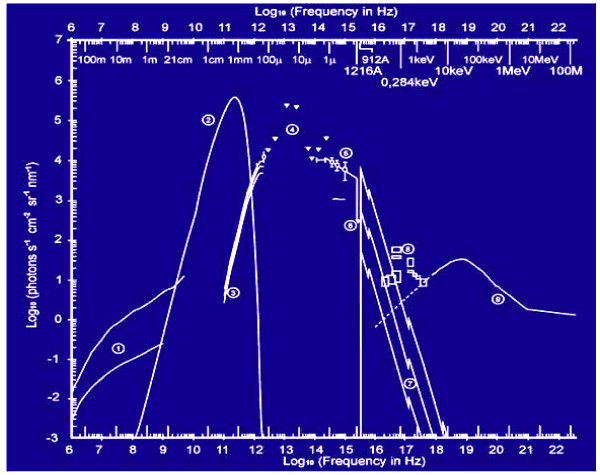
of spacecraft - **Lavochkin Research Production Association of Russian Space Agency.**



Planned launch date **of the mission is 2007.**

The orbit of the mission :

apogee - 85 200 km
perigee - 8 370 km
declination - 51.5 °
period is equal to 28 hours
Guarantied time of activity - 5 years
Scientific payload mass - 2100 kg
Pointing accuracy of radiotelescope - 40"



Project “CORONAS-PHOTON”

Goal Of The Project - Investigation of the process of energy accumulation and its transformation to the energy of accelerated particles during solar flares, study of the acceleration mechanisms, propagation and interaction of the fast particles in the solar atmosphere. Study of the solar activity correlation with physics-chemical processes in Earth upper atmosphere.

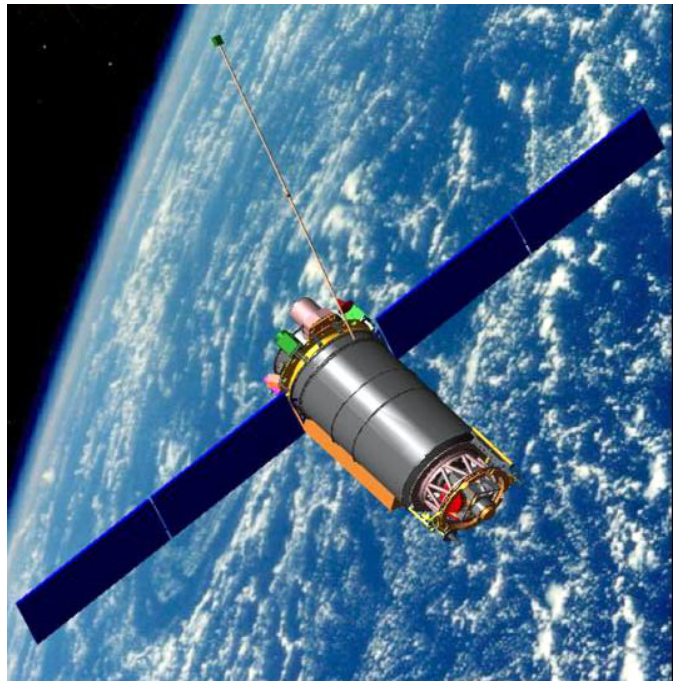
The spacecraft launch of the “Meteor-3” type is planned for 2007.

Leading research institute - Moscow Engineering Physics Institute (State University)

E-mail: kotov@mephi.ru

Leading design organization responding for the spacecraft “CORONAS-PHOTON” - Scientific-Research Electromechanic Institute, (Moscow region, Istra).

Planned launch date **of the mission is 2007.**



Main characteristics of the spacecraft:

Height of circle orbit - 500 км

Inclination - 82.5°

Pointing accuracy of the orientation to the Sun - <10`

Minimum duration of the active operation in orbit - 5 years

Mass of scientific payload - 700 кг

Main objectives of the mission "CORONAS-PHOTON"

- Electromagnetic solar flare radiation and neutrons
  - Study of the temporal dynamic of hard electromagnetic radiation from full disk in a wide energy range from EUV to 2000MeV;
  - Study of spatial and temporal dynamics of hot plasma regions in Solar atmosphere by observation of X- line radiation;
  - Nuclear gamma-lines spectroscopy of Solar activity regions;
  - Detection of solar neutrons with energies higher 20MeV;
  - Measurement of linear polarization and rapid variability of hard X-ray emission during the flares;
  - Monitoring of the Solar extreme ultra-violet (EUV), soft and hard X-ray emissions.

Charge particle environment measurements

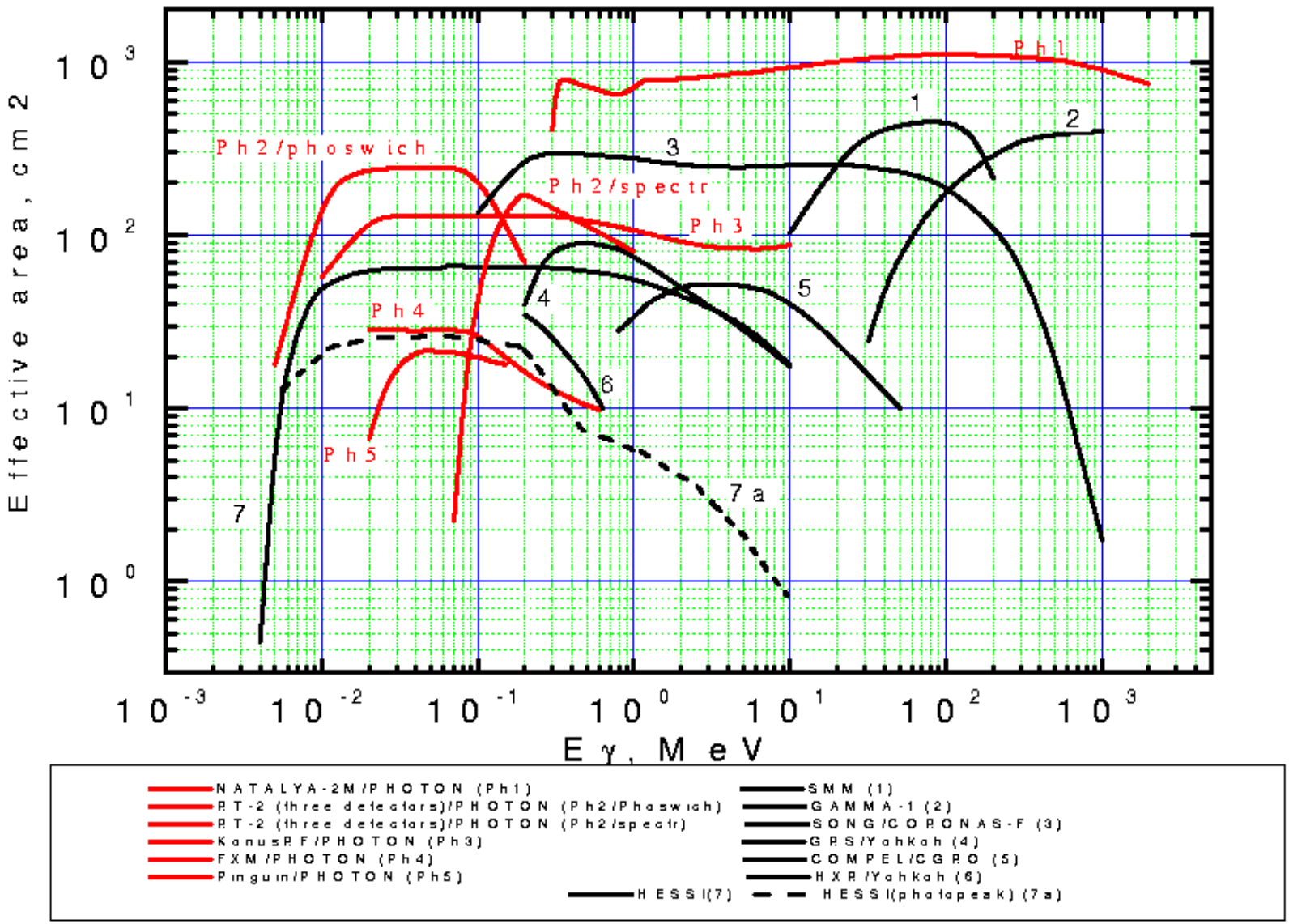
- Monitoring of energy and angular distributions of electrons and protons;
- Measurement of nuclei energy and mass distributions;

Simultaneously astrophysical observations

- Study of hard X-ray and gamma-radiation from gamma-burst;
- Study of X-ray radiation from the bright local sources along Ecliptic plane;

Simultaneously Geophysical observations

- Monitoring of Earth upper atmosphere by occultation measurements of EUV and soft X-rays radiated by the quite Sun.


Effective area of gamma- and X-ray detectors
on board solar satellites
(Instuments of CORONAS-PHOTON mission
are marked by red letters)
Effective area, cm2
10 3
10 2
10 1
10 0
10 -3
10 -2
10 -1
10 0
10 1
10 2
10 3
Eγ, MeV
Ph1
Ph2/phoswich
Ph2/spectr
Ph3
Ph4
Ph5
1
2
3
4
5
6
7
7a
NATALYA-2M/PHOTON (Ph1)
RT-2 (three detectors)/PHOTON (Ph2/Phoswich)
RT-2 (three detectors)/PHOTON (Ph2/spectr)
KanusRF/PHOTON (Ph3)
FXM/PHOTON (Ph4)
Pinguin/PHOTON (Ph5)
SMM (1)
GAMMA-1 (2)
SONG/CORONAS-F (3)
GRS/Yohkoh (4)
COMPEL/CGRO (5)
HXR/Yohkoh (6)
HESSI(7)
HESSI(photopeak) (7a)

THE NUCLON PROJECT

Goal Of The Project -

- **astrophysical investigations of our Galaxy. Direct cosmic ray (CR) measurements in extremely wide energy and charge range in the near-Earth space will allow solving the following fundamental problems in CR astrophysics:**
- **to verify astrophysical models of high-energy CR origin, acceleration and propagation in our Galaxy;**
- **to verify an astrophysical model of intrastellar nucleus synthesis with neutron capture, to investigate chemical evolution of matter in our Galaxy.**

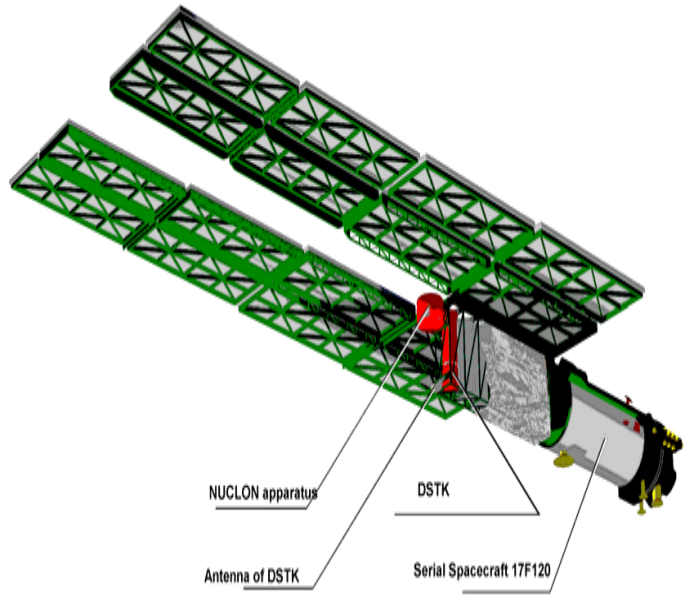
Leading scientific organization:

- **Skobeltsyn Institute of Nuclear Physics, Lomonosov Moscow State University**

Planning leading organization-elaborator:

- **Frunze federal state unitary enterprise**
- **KB "Arsenal"**

Planned launch date **of the mission is 2008.**



Supposed scheme of mounting of the NUCLON and DSTK devices in a regular satellite

The basic technical parameters of the "Nuclon" apparatus are:

- Geometrical factor
  - >0.10 m2sr for the high-energy component of the NUCLON apparatus
  - >0.25 m2sr for the low-energy component
- Weight of scientific equipment <60 kg
- Power consumption <95 W
- Maximum size > 400x400x350 mm3 (the NUCLON apparatus is a monoblock)
- Flow of scientific and auxiliary information <24 Mbyte per day
- Exposure time in orbit >1 year
- Orbit characteristics and accuracy of orientation in space are determined by parameters of a regular satellite

“PHOBOS-SOIL” MISSION

Goal Of The Project - is delivery of Phobos soil samples to the Earth and for conducting scientific research for Phobos and Mars.

The basic scientific and technical tasks are:

- **Determination of Phobos physical and chemical characteristics, distinctions of its internal structure, orbital and self-motion;**
- **Landing onto the heavenly body characterized by low gravitation;**
- **Launch from Phobos and delivery of the re-entry vehicle with the soil samples to the Earth;**
- **Determination of the soil sample chemical composition;**
- **Composition determination for the main rocks and their elements;**
- **Investigation of the solar wind interaction with Phobos;**
- **Study for the Phobos environment physical parameters (dust and gas components, space rays, magnetic field);**
- **Remote investigation of the Mars atmosphere and surface.**

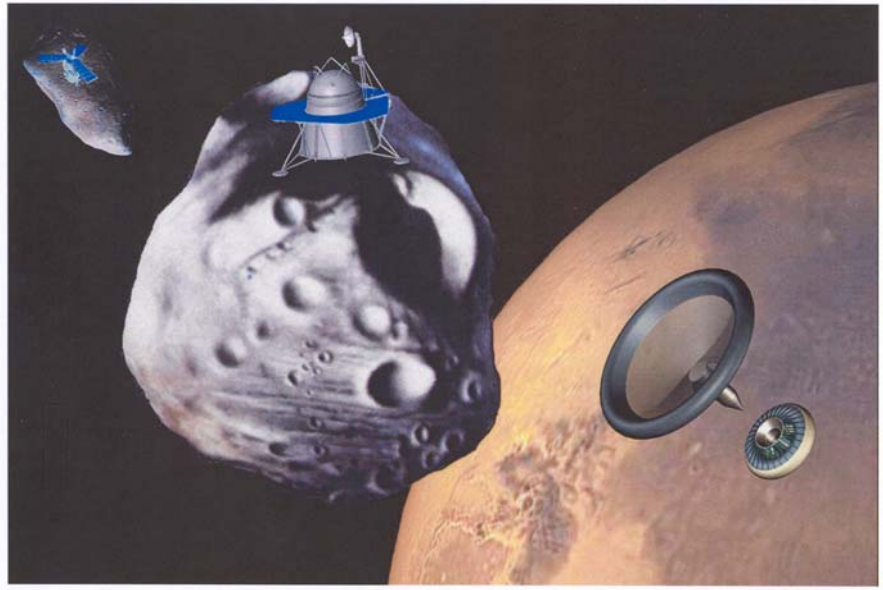
Head institution **on scientific payload - the Space Research Institute of Russian Academy of Sciences**

E-mail: lzelenyi@iki.rssi.ru

Main organization of spacecraft -

Lavochkin Research Production Association of Russian Space Agency

The spacecraft launch is planned for 2009



The mass of the Phobos soil pattern, delivered on the Earth - 0,1 кg.
Flight duration to the Mars activity sphere - 850 days.
Velocity at the Earth atmosphere entry - 11,56 km/s.
Flight duration to the Earth - 285 days.
Total mission duration - 1030 days.

WSO - UV

The Spectrum-UV Project (The World Space Observatory)

The important task is to establish the connection between the nearby (z < 2) Universe, covering 80% of the cosmic time and containing most of the baryonic matter, and the early Universe which is being studied in great detail at the redshifted UV wavelengths with the new generation of ~10m telescopes.

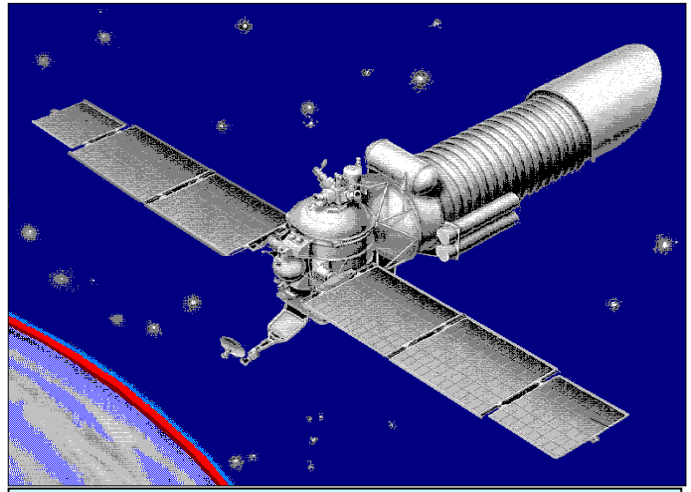
The main contractor on SI — **INASAN**

E-mail: aboyar@inasan.rssi.ru

The main contractor on the Spacecraft - **Lavochkin Association.**

Planned launch date **of the mission is 2010.**

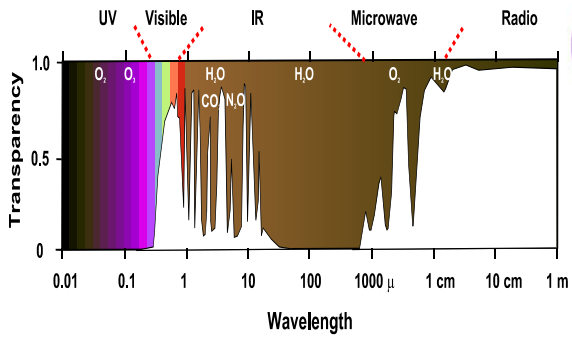
Russia | Germany | Italy | Ukraine

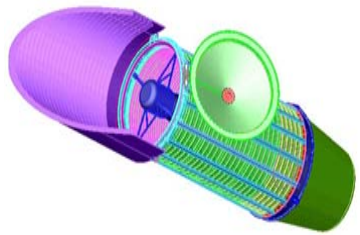


Orbit Parameters:

apogee height – 300 000 km
perigee height – 500 km
inclination - 51 °
The operational lifetime – not less than 5-7 years
Scientific payload mass – 2 500 kg

Transparency of the Earth atmosphere

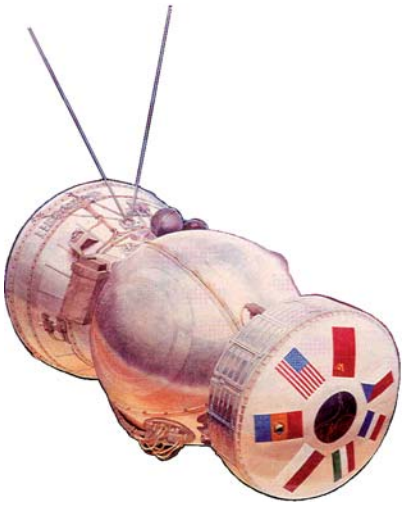




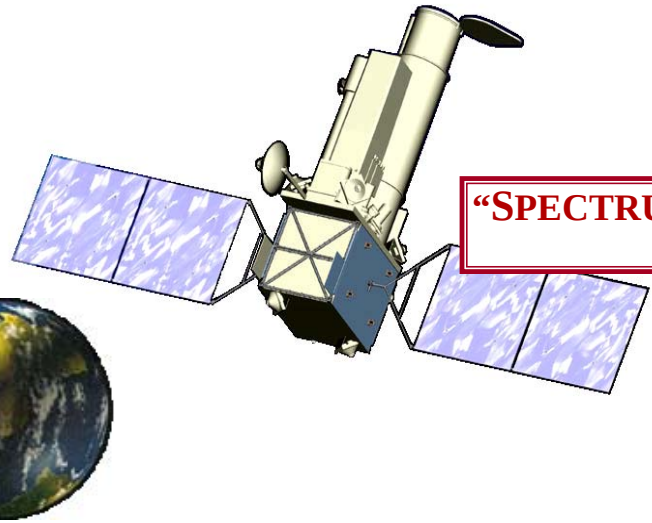
Telescope T-170M

FUNDAMENTAL SPACE RESEARCH

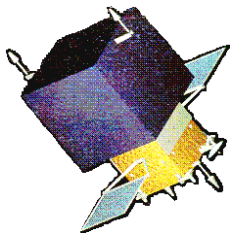
PLANNED LAUNCH DATE OF THE MISSIONS IN 2010-2015



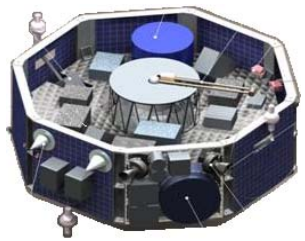
"BIOCOSMOS -1"
(2010-2015)



"SPECTRUM-X-GAMMA"
(2011)



"GAMMA –400"
(2013)



"RESONANCE"
(2012)

«BIOCOSMOS-1» PROJECT

Goal Of The Project – **is research of cellular and tissue cultures, unicellular organisms, insects, fish, amphibia, seeds and germs of higher plants, rats of Wistar Hannover strain**

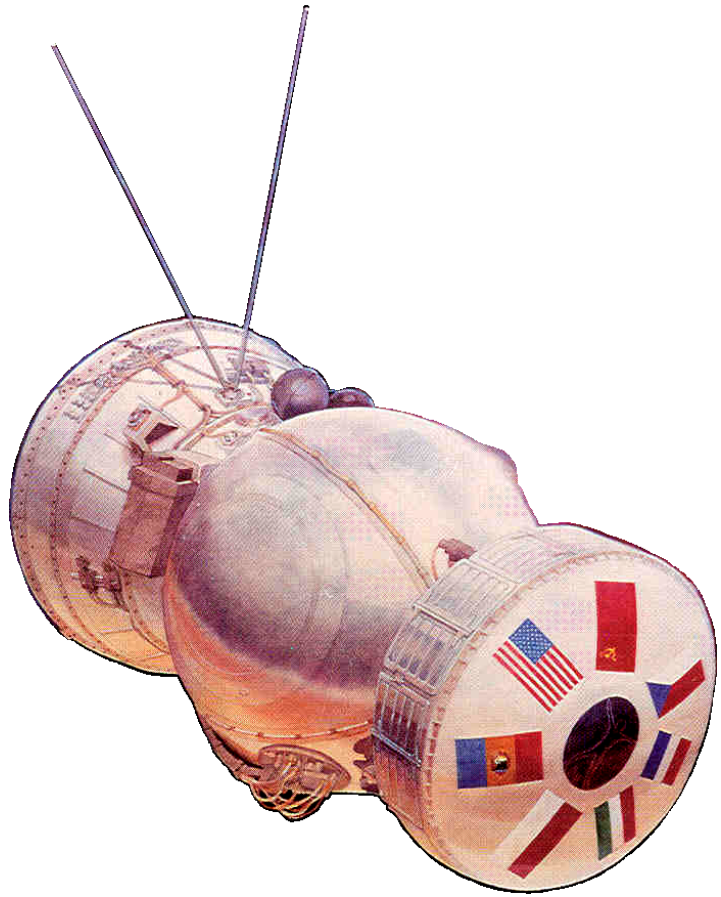
The inflight experiments will be conducted aboard spacecraft "Bion-M".

The leading scientific organization and coordinator of the BioCosmos project is the State Scientific Center of Russian Federation – Institute of Biomedical Problems of Russian Academy of Sciences (IMBP).

E-mail: grigoriev@imbp.ru, ilyine@imbp.ru

The leading industrial company – is the State Space Rocetry Production Research Center "TsSKB-Progress" by the Rosaviacosmos

The preliminary date of launch of two "Bion-M" apparatus – from 2010 to 2015



Mass of spacecraft – 6 300 kg

Mass of payload – up to 900 kg

Orbital parameters:

- **apogee - 394 km**
- **perigee - 226 km**
- **inclination - 62,8°**

Total mission duration - 45 days

"SPECTRUM-X-GAMMA" PROJECT

Scientific Payload –

Wolter-telescopes eROSITA (extended ROentgen Survey with an Imaging Telescope Array, MPE, Germany), wide filed X-ray monitor Lobster (LU, UK), and coded-mask telescopes ART (IKI, Russia) were defined as core instruments to be mounted on the SRG platform.

The mission eROSITA will perform the first imaging all-sky survey in the medium energy X-ray range up to 10 keV with an unprecedented spectral and angular resolution. The main scientific goals are :

- to detect systematically all obscured accreting Black Holes in nearby galaxies and many (> 170 000) new, distant active galactic nuclei in the hard band;
- to detect the hot intergalactic medium of 50-100 thousand galaxy clusters and group and hot gas in filaments between clusters to map out the large scale structure in the Universe and to find in particular the rare massive distant clusters of galaxies for the study of Dark Energy;
- to study in detail the physics of galactic X-ray source populations, like pre-main sequence stars, supernova remnants, and X-ray binaries.

The goal of Lobster, as for any ASM, is to approach the limit of "all the sky, all the time".

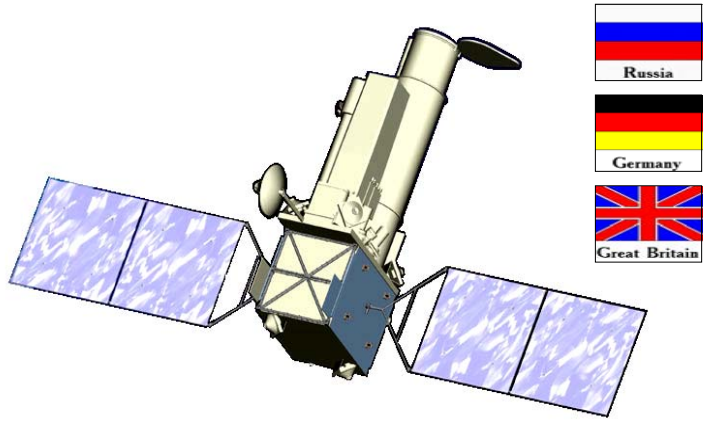
ART instrument is designed for the following tasks :

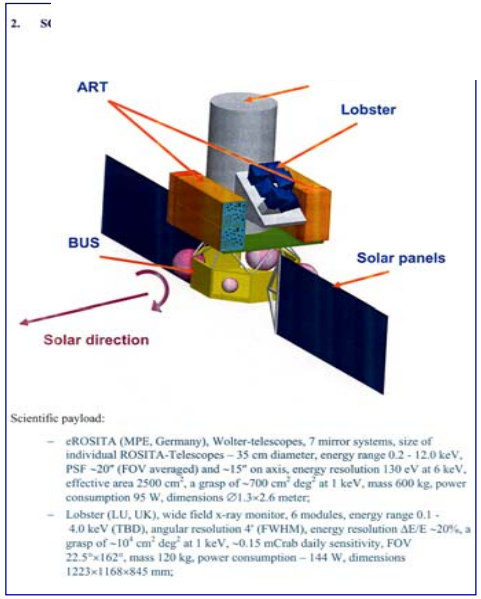
- Extend the energy coverage of the SRG observatory up to 120 keV;
- Search for heavily absorbed / Compton thick sources (both extragalactic and Galactic);
- Provide a necessary high energy extension of AGN spectra to allow detailed modeling of their spectra, including reflection component;
- Provide the information on the hard tails in the spectra of galaxy clusters to constrain the strength of the magnetic fields in the inter cluster medium;
- Study broad band spectra of Galactic objects (including binary systems, anomalous pulsars, supernova remnants);
- Study non-thermal component in the Galaxy diffuse emission.

Head institution **on scientific payload - the Space Research Institute of Russian Academy of Sciences (IKI RAN) :**
E-mail: sunyaev@hea.iki.rssi.ru

Head institution **on "GRANAT" spacecraft – Lavochkin Association .**

Planned launch date **of the mission is 2011.**





Scientific payload:

- eROSITA (MPE, Germany), Wolter-telescopes, 7 mirror systems, size of individual ROSITA-Telescopes – 35 cm diameter, energy range 0.2 - 12.0 keV, PSF ~20" (FOV averaged) and ~15" on axis, energy resolution 130 eV at 6 keV, effective area 2500 cm^2, a grasp of ~700 cm^2 deg^2 at 1 keV, mass 600 kg, power consumption 95 W, dimensions ∅1.3×2.6 meter;
- Lobster (LU, UK), wide field x-ray monitor, 6 modules, energy range 0.1 - 4.0 keV (TBD), angular resolution 4' (FWHM), energy resolution ΔE/E ~20%, a grasp of ~10^4 cm^2 deg^2 at 1 keV, ~0.15 mCrab daily sensitivity, FOV 22.5°×162°, mass 120 kg, power consumption – 144 W, dimensions 1223×1168×845 mm;

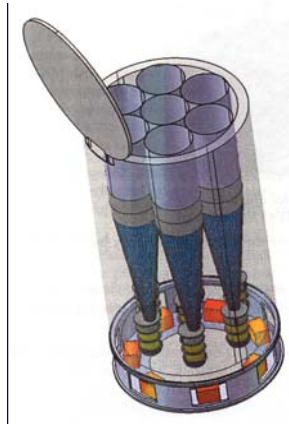


Fig. 3.1.3: schematic view of the eROSITA telescopes with Wolter-I optics + baffles (grey) and the 7 CCD-cameras including their (red) electronics boxes.

PAILOD CHARACTERISTICS:

Orbit parameters:

apogee – 200 000 km
perigee – 500 km
inclanation - 51.5 °
period – 4 days

Life time – not less than 3 year
Scientific instruments - 2 750 kg

Project “RESONANCE”

Goal Of The Project - study of resonance interactions of electromagnetic emissions with charged particles in the Earth’s magnetosphere.

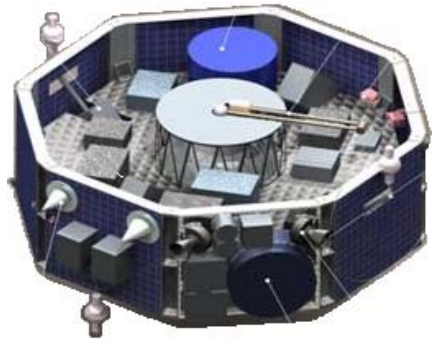
Head institution **on scientific payload - the Space Research Institute of Russian Academy of Sciences**.

E-mail: lzelenyi@iki.rssi.ru

Main organization of spacecraft - **Lavochkin Research Production Association of Russian Space Agency**.

Now the project «Resonance» is at the stage of DS and recommended to the Russian Federal Space Program of 2006 – 2015 years.

The spacecraft launch is planned for 2012.



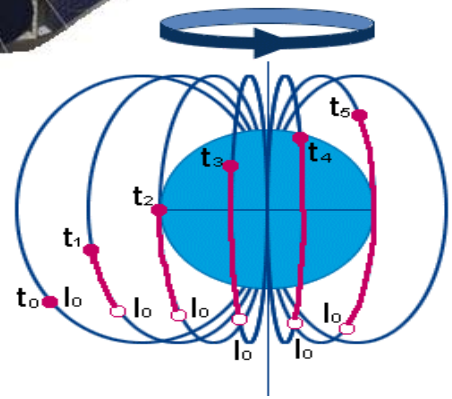
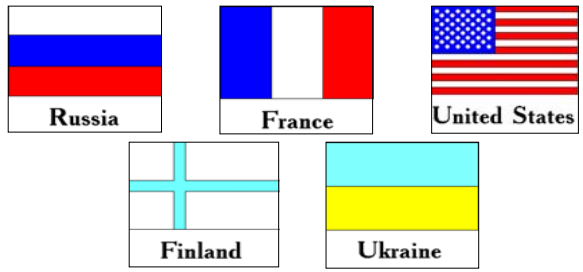


Illustration of the RESONANCE satellite motion along magnetic flux tube mapped of the heating station

Parameters of RESONANCE satellites orbit:

Perigee -	**1 500 км;**
Apogee -	**26000 км;**
Inclination –	**63°**
Period –	**8 hours**
Mass of scientific payload –150 кg	



THE GAMMA-400 PROJECT

Goal Of The Project - **determine the nature of high-energy gamma-ray space emission in the energy range above 30 GeV**

BASIC PHYSICAL PERFORMANCES OF THE TELESCOPE :

- Energy range - 0.01-1 TeV
- Sensitive area - 80x80 cm^2
- Geometrical factor - 3000 cm^2sr
- Aperture - 90°
- Angular resolution - 3° at E ~ 10 GeV
- Energy resolution - 2% at E ~ 1 TeV
- Volume of telemetry data - up to 50 Mbytes/day

The Head Scientific Institute **is Lebedev Physical Institute**

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Planned launch date **of the mission is 2013**