

Russian programme for deep space exploration

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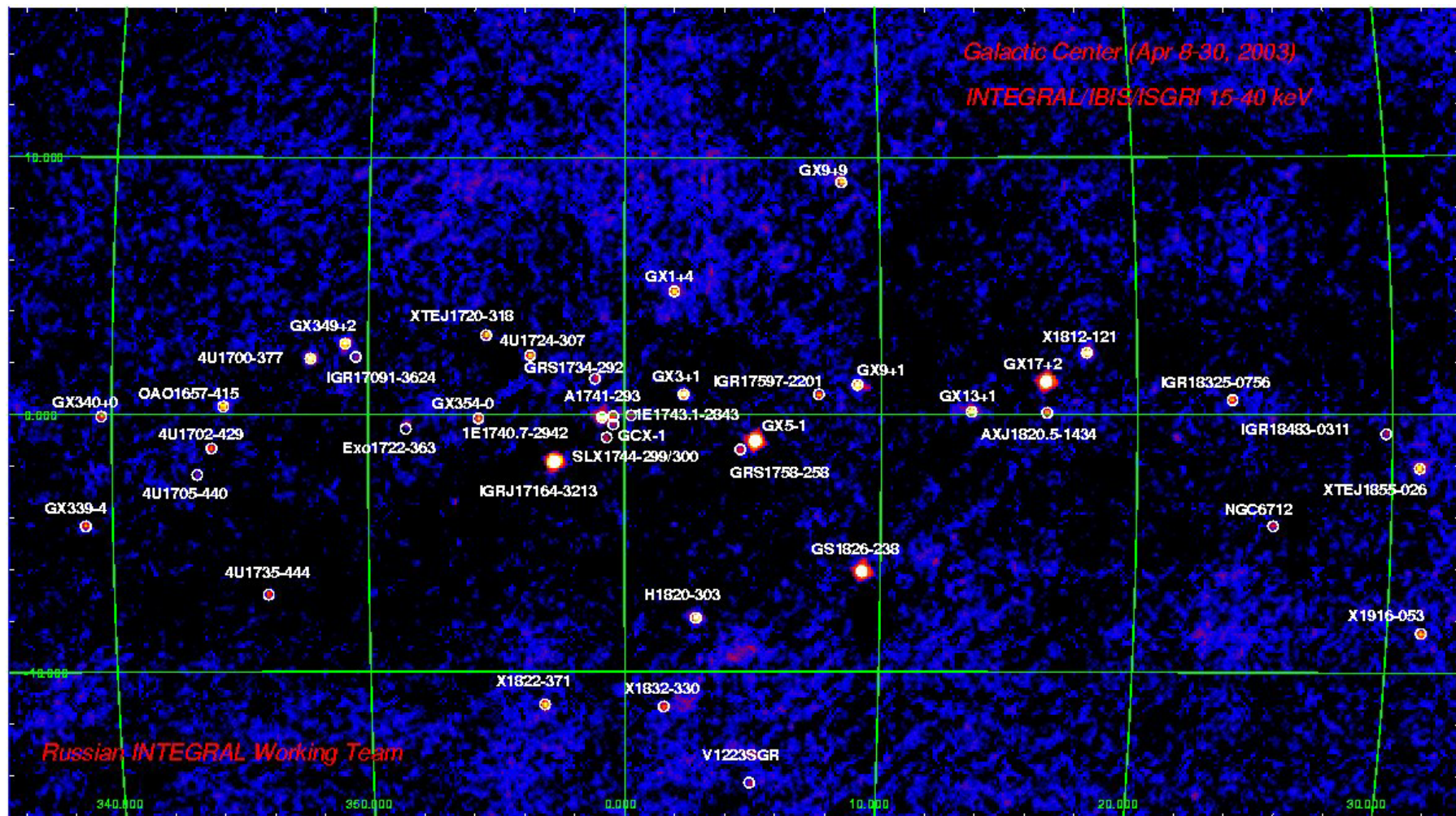
Space observatories

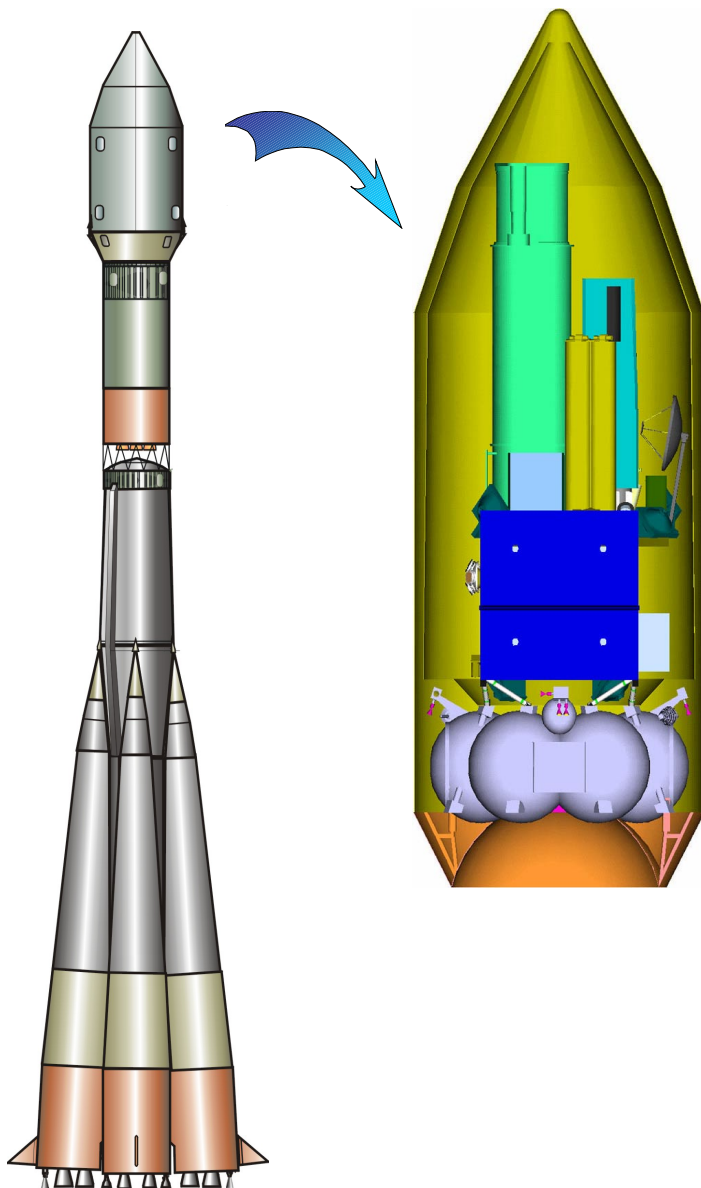
- SPECTRUM-XG
 - INTEGRAL launched in 2002;
 - SPECTRUM-XG cancelled in 2002;
 - descoped option of SPECTRUM-XG with launch on a Soyuz-class rocket (without SODART telescope) is under consideration
- RADOIASTRON
 - First in the launch list (2005)
- SPECTRUM-UV
 - World Space Observatory - UV
 - Soyuz-class rocket
 - Launch >2009

INTEGRAL

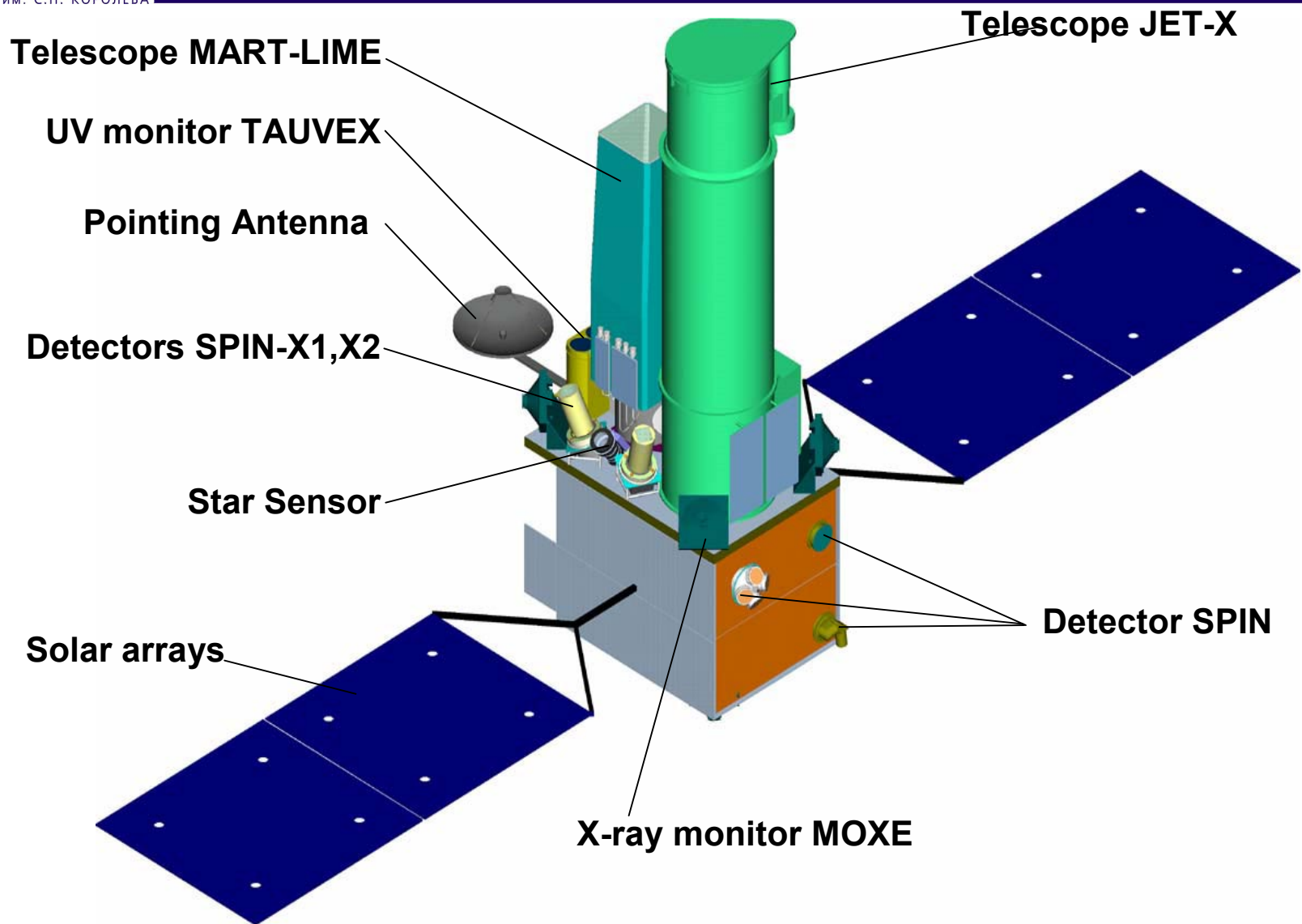
- The INTErnational Gamma-Ray Astrophysics Laboratory
- Developed by ESA with participation of Russia (Rosaviacosmos and RAS) and USA (NASA)
- Scientific instruments manufactured in France, Germany, Italy, Denmark and Spain
- Spacecraft delivered to orbit by Proton launcher
- Cost of project >600 Million USD
- Russian scientists have 25% share of observing time
- Russian INTEGRAL Science Data Center is developed in IKI

INTEGRAL: Deep survey of Galactic Center region, April 2003 (15-40 keV)





- Launch vehicle Soyuz-2 1b
- Upper Stage Fregat
- Cosmodrome Baikonur
- Satellite mass in operational orbit 2110 kg

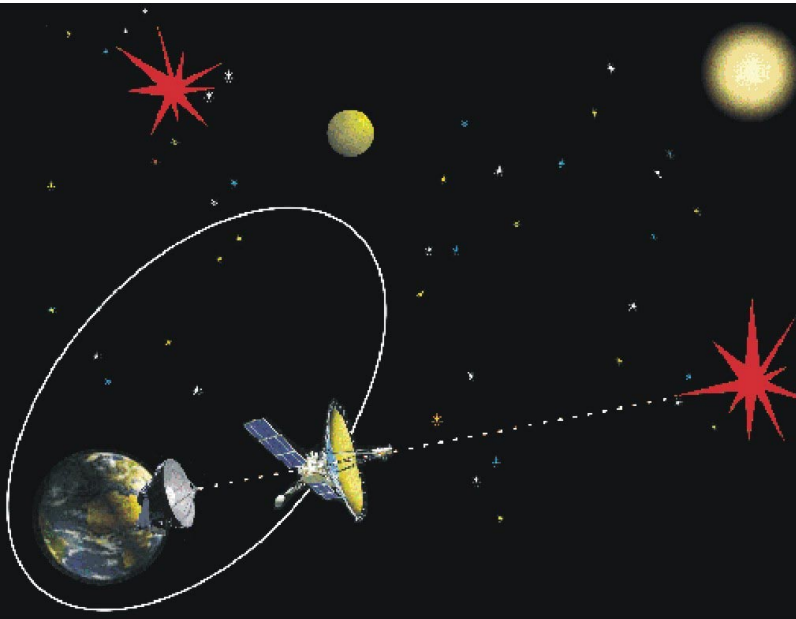


Note: Telescope EUVITA placed on opposite side of spacecraft

RADIOASTRON: expected dates and milestones

- Assembling (integration) SRT electronics and SRT antenna (EM) – (first half of 2003).
- SRT radio astronomical tests in Pushchino observatory – second half of 2003 (1st milestone).
- Systems integration and test spacecraft Spektr-R (EM) – first half of 2004 (2nd milestone).
- Integration and tests SRT together with Spacecraft (EM) – second half of 2004.
- SRT flight model radio astronomical tests in Pushchino – second half of 2004 (3rd milestone).
- Integration of SRT and Spacecraft (FM) – second half of 2004.
- Tracking stations (TS) preparation and verification – 2005 (4th milestone).

RADIOASTRON orbit and parameters



Period	$p = 9.5$ days
Semi-major axis	$a = 189\,000$ km
Eccentricity	$e = 0.853$
Perigee height	$H = 29\,000$ km



RADIOASTRON

PARAMETERS



Band (GHz)	0,327	1,665	4,830	18-25
Band width (MHz)	4	32	32	32
Fringe size (μ as) [base line 350 000 km]	540	106	37	7,1-10
Min. cor. flux (mJy) [RMS, with upgrated VLA, 300s integration time]	10	1,3	1,4	3,2

Courtesy: N. Kardashev

RADIOASTRON antenna

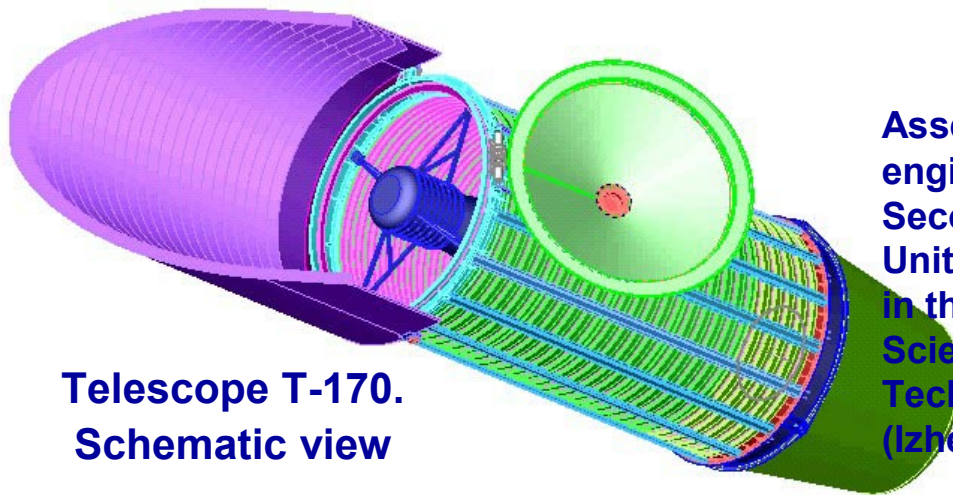


Courtesy: N. Kardashev



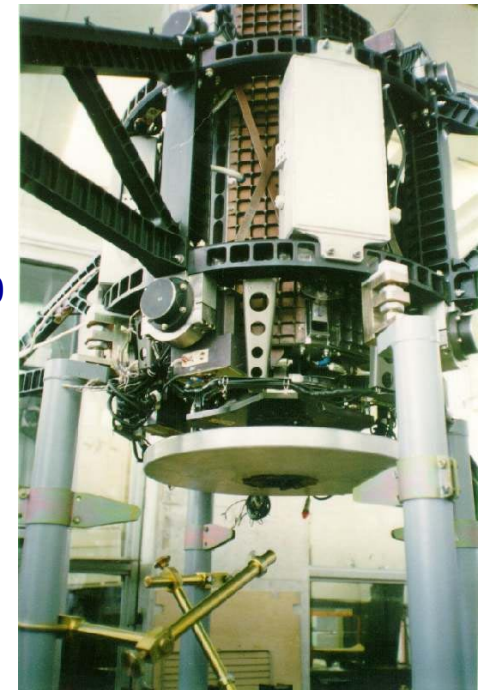
World Space observatory – UV

The present WSO – UV mission design consists of a 1.7-meter telescope, with three UV spectrometers in the focal plane, covering the spectral band from ~ 110 nm to the atmospheric cutoff with $R \sim 55,000$ and offering long-slit capability over the same band with $R \sim 1,000$, and a number of UV and optical imagers



Telescope T-170.
Schematic view

Assembly of the
engineering
Secondary Mirror
Unit (SMU) of T-170
in the «Voskhod»
Science and
Technology Center
(Izhevsk, Russia)



Courtesy: B. Shustov



Expected contributions to WSO

Russia:

- The delivery of the T-170M telescope, and
- a strong participation in the : Fine Guidance System, Focal Cameras, Spacecraft, Ground Segment, Assembly and Integration

Germany:

- Spectrometers
- A strong participation in the Ground Segment

Italy:

- Detectors

Israel:

- UV cameras

Spain:

- A strong participation in the Ground Segment

China:

- Launcher

Other countries

- Ground Segment, Scientific Instruments

ESA:

- Subsystems (under consideration)

Courtesy: B. Shustov

WSO Launcher Options Considered

Fairing
O 4.0/4.2 m

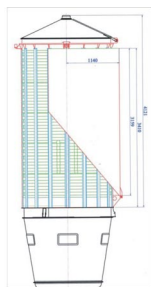
Static env.
3.65/3.86 m

Fairing
Length
10.5 – 12.0 m

GTO
Capability
5100 kg



LM3-B



**T170M in launch
Configuration**

T-170M + Inst. : 1570 kg

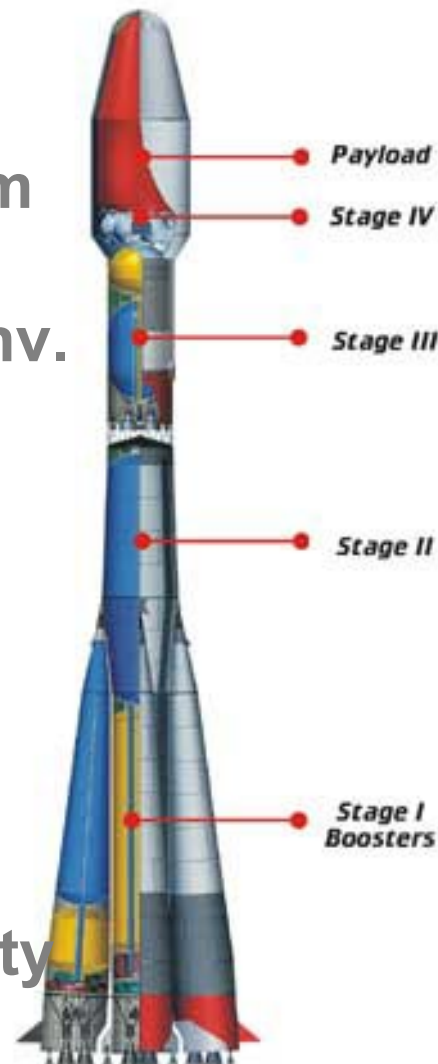


Fairing
O 4.11 m

Static env.
3.8 m

Fairing
Length
9.52 m

L Circ.
Capability
5500 kg



SOYUZ/ST



Planetary Exploration Programme



PHOBOS - GRUNT



Phobos Sample Return Mission

1. Basis for choice, goals, methods of study

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-
-

Phobos: Rationale for the target choice

- **Delivery to the Earth samples of relict matter and its investigation in the laboratories is one of the most important task of current Solar system exploration;**
- **scientific and technical solutions of a mission to Phobos have heritage (Phobos 1988) and choosing a mission to Phobos continues the strategy of planetary exploration in Russia;**
- **Phobos and Deimos are the most accessible small bodies for space research from the technical point of view;**
- **preparation and realization of a Phobos mission reflects interests of many institutes of the Russian academy of sciences - IKI, Vernadsky Institute, Applied Mathematics Institute, Institute of Radioelectronics, Institute of Earth Physics and others;**
- **besides Phobos investigation a mission to Phobos allows to study several important problems of Mars, its environment, some interesting problems of fundamental physics;**
- **the mission to Phobos is independent on any current space mission and complements current American and European program of Mars exploration and small bodies exploration that offers a basis for international cooperation.**

Phobos-Grunt mission: Scientific objections

Mars system science:

- Phobos investigation (regolith, origin and evolution of the Martian moons),
- Martian environment conditions (dust, plasma, radiation),
- Monitoring of the Martian atmosphere global dynamics and the surface.

Goals:

- **study physical and chemical characteristics of Phobos regolith and subsurface layers *in situ* and in laboratory** - these data can provide information on properties of primordial matter of the Solar system;
- **study of the role played by asteroidal impacts in the formation of terrestrial planets, in the evolution of their atmospheres, crusts, and inventories of volatiles;**
- **study of the origin of the Martian satellites and their relation to Mars** - these data can help in our understanding of their evolution and the origin of satellite systems near other planets;
- **search of possible life or paleolife;**
- **study of peculiarities of orbital and proper motion of Phobos**, what is important for understanding their origin, internal structure, celestial mechanics applications;
- **study of the Martian environment** (dust, gas, plasma components) what is important to study of treatment processes of small body regolith under influence of external conditions and creation of engineering model of the Martian environment for future Martian missions;
- **Monitoring of Martian atmospheric dynamics and seasonal climate changes.**

PHOBOS-GRUNT:

Strawman Payload

Instrument	Index	<i>On Phobos</i>	<i>In orbit</i>
- TV-system	TVS		+
- Chromatomass-spectrometer	ChS	+	-
- Manipulator with instruments	MPL	+	-
- Gamma-spectrometer	GSP	+	+
- Neutron spectrometer	NSP	+	+
- Mass-spectrometer	MSS	+	+
- Seismometer	SSM	+	-
- Long-waves radar	LWR	+	+
- Optical Spectrometer	AOS	+	+
- Dust counter	DUC	+	+
- Ion comp. spectrometer	ICS	+	+
- Solar sensor	SSR	+	+
- Precise transmitter	PTR	+	+
		+	

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-
-

Phobos-Grunt project: Current status

The PHOBOS-GRUNT project is the only national planetary project in the current decade.

The Lavochkin / Babakin space association is the main contractor of the sc ROSAVIACOSMOS announces that the PBOBOS-GRUNT mission will be launched in 2009.

About 30 proposals for scientific experiments have been received for the mission from Russian scientific teams. A final selection of experiments for the mission from scientific and technical point of view is to be done.

European and American science groups are invited to participate in the mission (scientific instruments, ballistic, ground support measurements).

Participation in ESA and NASA missions

- Participation with experiments and in experiments
 - Mars Odyssey (HEND)
 - Mars Express
 - Venus Express
 - MSL, ...
- Joint Missions
 - **Bepi Colombo** (already included in Russian programme)

Potential Missions

- Venus: long-living (small station to survive from 2 month to 1 year on the surface of Venus)
- Moon: a set of penetrators (ex. 6) to study moon interior and possibly an orbiter – under consideration as a potential joint mission

Venera-D

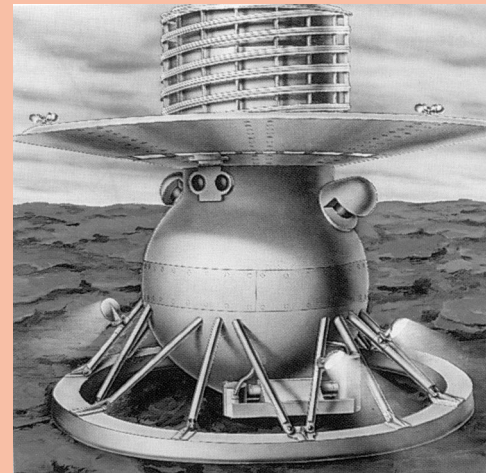
**Proposal of IKI and Lavochkin association to national programme of fundamental studies in space for 2006-2015 as a Russia-led mission:
Descent module with a possibility of long survival on the surface of Venus (2013)**

Venus : a record of success in Soviet space exploration (1967-1985). Russia still has in possession this the unique heritage

- **Veneras - 4, 5, 6, 7, 8**
- **1967-1972;**
- **Souyz launches**



- **Veneras - 9, 10, 11, 12, 13, 14, Vega -1, 2**
- **1975-1985;**
- **Proton launches**



Venera-D:

scientific measurements and main features

- **Pictures of the surface of Venus during the descent below the cloud level (at the night side; using surface NIR emission);**
- **Profiling of the atmosphere during the descent (T, P, H₂O profile below 20 km; sulfur compounds);**
- **Determine xenon isotope composition; more accurate measurements of other gases;**
- **In situ measurements on the surface;**
- **Long-term (several months) geophysical measurements at the surface to study the interior and climate of Venus (through seismometry and pressure record)**

- **Preliminary studies have demonstrated the existence of enabling technologies (thermostatic compartment for ~1 month duration or high-temperature electronics for longer period; high-temperature energy sources, ...)**
- **Other scenarios (ex., long-living balloons) will be considered at assessment stage**
- **Estimated price of the project to Rosaviakosmos appr. 1600 MRoub or 300 MEuros (2003)**