LAVOCHKIN ASSOCIATION:

OPPORTUNITIES FOR JOINT INVESTIGATIONS OF THE SPACECRAFT STATIC ELECTRICITY CHARGING

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1. INTRODUCTION

The Lavochkin Association is one of the leading Russian enterprises in the field of development and operation of spacecraft of various purpose.

It is famous by its spacecraft that carried out successful researches of the Moon, Mars, Venus and interplanetary space. The mostly considerable achievements of space vehicles produced by Lavochkin Association are the following:

- Delivery to the Earth of soil samples from the Moon;
- Study of a surface of the Moon by the mobile «Lunokhod» lunar rover;
- Execution of the soft landing and transmission of the image of a surface of the Moon and Venus;
- Exploration of the Halley's comet

and some others.

Many scientific projects were fulfilled with international cooperation and were carried out together with the Institute of Space Research of the Russian Academy of Sciences.

At present in Lavochkin Association many projects involving exploration of the Universe, planets, near Earth space, space communication are under development.

2. THE PROBLEM OF THE PROTECTION AGAINST HARMFULL EFFECT THE CHARGING OF SPACECRAFT MADE BY LAVOCHKIN ASSOCIATION

One of the basic tasks of our enterprise is the development of reliable spacecraft with long life-period. It is obvious, that protection of spacecraft against harmful effect of a static electricity is necessary for the execution of this task.

The following basic methods of protection are used:

- Provision of the surface equi-potential;
- Shielding of cables of on-board equipment.

For creation equipotential of a surface the standard metal crosspieces, metallized multilayer thermal insulation, transparent conducting coverings on optical surfaces conducting paints are used. The standard as much as possible allowable area dielectric of a surface without a metal substrate makes 0.2 $м^2$. The tests of charging of materials or designs in vacuum chambers will present an occasion of definition of efficiency of the used design approaches for the maintaining of the equipotential of surfaces.

With the purpose of study of serviceability of the spacecraft under effect of the ESD, beginning from the «Coupon» spacecraft, the ground testing of technological breadboard models of spacecraft for stability to the ESD will be carried out. The generators current pulses and high-voltage are used. On the basis of results of tests the completions of screens or systems will be carried out, if necessary.

As per our knowledge, the monitoring of the static electricity charge during the spacecraft operation would allow to solve the following problems:

- To make the decisions on the spacecraft guidance and control;
- To reveal the reasons of malfunctions and failures of the onboard equipment;
- To evaluate the efficiency of protection against the charge of a static electricity;
- To receive experimental data about conditions of operation of spacecraft in various geophysical conditions.

Experience of operation of such spacecraft as «Granat», «Coupon», «Interball – 1 & 2» and others confirms the efficiency of used technologies of protection against harmful interference of a static electricity.

However, the enterprise look to development of used technologies in connection with the constantly growing requirements to service life and reliability of spacecraft.

The projects of spacecraft, offered to all interested organizations, are listed below at which realization the cooperation in various directions of this field is probable.

3. INTERNATIONAL PROJECT OF A SPACECRAFT «SPECTRUM - RG»

The purpose: astrophysical researches in various ranges of the electromagnetic spectrum.

Scientific tasks:

- Researches of x-ray and gamma- radiation in a range 0.03 keV - 10 MeV;
- Experiments in the field of astrophysics of high energies.

Planned launch date: 2001.

Orbital parameters:

- altitude of the perigee	500 kms;
- altitude of the apogee	200000 kms;
- inclination	51.5 degrees;
- orbital period	4 days;
- attitude	three-axis.

Weight:

- The Spacecraft 6000 kg;
- The astrophysical module 2800 kg;
- The scientific equipment 2750 kg.

As per our understanding, for the operation of scientific and housekeeping equipment of this spacecraft absolute potential in tens Volt is not dangerous. However, taking into account various conditions of light exposure and wide use dielectric materials inside and outside of compartments of the spacecraft, the occurrence of a differential charge between separate elements of a spacecraft is possible.

For the control by the charge of the static electricity it is supposed to establish the monitoring system of a charge.

It is planned to use the equipment of development of Novosibirsk state university and (probably) of Research institute of nuclear physics of the Moscow state university.

The system composition will be as follows:

- Sensors of an electrical field;
- Sensors of a complete current;
- Sensors of a difference of potentials;
- Detectors of flows of the charged particles of high energy (probably), able to cause the charging inside of compartments of a spacecraft;
- The block for recording, storage and distribution of the data in telemetry system of a spacecraft.

For a final choice of a range measurement parameters, the numbers and installation places of sensors it is supposed to perform the simulating of a charge of the «Spectrum -RG" Spacecraft together with MSU.

Expected mode of operation of the system - continuous.

Now there is a process of definition of parameters of the monitoring system of the spacecraft charging. The end of this stage of work - March 1999. The participation in this work of the interested organizations both at this stage, and on subsequent ones is possible.

4. INTERNATIONAL PROJECTS «SPECTRUM - R», «SPECTRUM - UV»

The spacecraft «Spectrum - R» is intended for radio-astronomical researches in the range of wavelengths of 1, 35; 6; 18; 92 cm.

The aperture - 10м.

The astrophysical module is identical to the module of a spacecraft «Spectrum - RG».

Orbital parameters are as follows:

- altitude of the perigee 2000 kms;
- altitude of the apogee 80000 kms;
- inclination 51.5 degrees.
- attitude – three-axis

Planned date of launch - after 2001.

The «Spectrum - UV» spacecraft is intended for researches in the ultra-violet band of wave lengths 100 - 3500A.

The aperture – 1.7м.

The astrophysical module is identical to the module of a spacecraft «Spectrum - RG».

Orbital parameters:

- altitude of the perigee 500 kms;
- altitude of the apogee 300000 kms;
- inclination 51.5 degrees.

Attitude – three-axis.

Planned date of launch - after 2001г.

The installation on these spacecraft of monitoring systems of a charge is supposed.

The installation of the equipment for realization of applied experiments on all aspects of a charge of spacecraft by a static electricity (probably discussion of realization of such experiments on a spacecraft «Spectrum - RG») is possible.

The decisions on a choice of parameters of the monitoring system of the charging and additional equipment should be accepted in 1999.

Besides the participation of the interested organizations in development of the programs and realization of ground tests on stability to the ESD of all craft of the «Spectrum» series is possible.

Time-frame of realization of works - 1999-2001г.

5. INTEGRATED INTERNATIONAL MULTISATELLITE PROJECT “INTERBALL”

The spacecraft «Interball-1» and «Interball-2» are intended for the study of solar-terrestrial physics and space plasma.

The parameters of the orbit:

	tail probe	auroral probe
- altitude of the perigee, km	315	770

- altitude of the apogee, km	200000	20000
- inclination to the equator, deg	65	65
- orbital period, h	96	6

Appearance of spacecraft, accommodation, applicability, measurement parameters and the countries - developers of the scientific equipment are shown in a fig. 5.

The space vehicles «Interball-1» (tail probe) and «Interball-2» (auroral probe) work on an orbit now. The information, received by the international collective, is known for the experts. However, it would be desirable to note, that the special measures undertaken by collective of the developers of a spacecraft from Institute of Space Researches, Lavochkin Association and other countries for protection of this device against harmful influences of a static electricity and control of absolute potential of a space vehicle in flight completely have justified themselves (for a part of the scientific equipment established on a space vehicle undesirable is potential even in some tens Volt).

Lavochkin Association (as agreed with Institute of Space Researches of the Russian Academy of sciences) informs an opportunity to perform with the help of space vehicles « Interball - 1 & 2 » applied experiments on study of a charge by a static electricity. It is represented to us, that the complex of scientific units mounted on these devices allow to fulfill a number of interesting works.

The program of works should be made as soon as possible.

6. SPACECRAFT OF A "COSMOS" SERIES

Approximate date of launch - end 1999, 2000г.

Parameters of the orbit:

- altitude of the perigee 600 kms;
- altitude of the apogee 40000 kms;
- inclination 63 degrees;
- Geo-stationary orbit.

The accommodation of the equipment (developed by the Russian enterprises) for the control of a charge, realization of measurements and applied experiments on study of this process in interests of all interested parties is possible on these spacecraft.

The work should be begun immediately.

7. OTHER OPPORTUNITIES

Sections 3 - 6 contain the offers represented to us as the most real, urgent and, accordingly, attractive from the point of view of their realization. However, the opportunities of our enterprise allow to carry out researches of a charge on spacecraft intended for exploration of other planets, and development of special technological spacecraft for the researching of the spacecraft charging.

We would be glad to consider all offers for cooperation.

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