Microsatellite "Chibis-M" (25.01.2012 – 15.10.2014)
Results, lessons and prospects


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10th Symposium on Small Satellites for Earth Observation of the International Academy of Astronautics, Berlin, April 21, 2015
1. Specificity of space experiments in the infrastructure of Russian segment of the ISS by using the ship "Progress".

2. Microsatellite “Chibis-M”

3. Prospects on the MS in the infrastructure of the Russian segment of the ISS.
Specificity of space experiments in the infrastructure of the ISS by using the ship "Progress".


Microsatellite «Kolibri-2000» (weight 20.5 kg) was designed and manufactured in IKI RAS. Its delivery to the orbit has been performed in the infrastructure of ISS in 2002, that was the first step of the program on using of microsatellite for fundamental space research.

Despite its small size the microsatellite (MS) was carrying 3.6 kg. of scientific payload which was used for the realization of wide range of scientific research in the field of «classical» cosmophysics, also the study was made of space weather, atmospheric and ionospheric processes supposedly associated with thunderstorm activity manifested in the detection of electrons near the equator, due attention was paid to solve the problems of space education.
Specificity of space experiments in the infrastructure of the ISS by using the ship "Progress".

For delivery of the MS on the ISS and subsequent MS separation from TCV are used transport-launch container (TLC).

Left TLC "Chibis-M". Right - comparizen TLC "Kolibri-2000" (left) and "Chibis-M". Due to the thicker the line the Chibis-M" (mass of 40kg.), volume TLC was increased by 10% compared with TLC "Kolibri-2000" (mass 20.5 kg).
Specificity of space experiments in the infrastructure of the ISS by using the ship "Progress".

Simulator docking frame "Progress"
Installation of a microsatellites in the TLC.

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Specificity of space experiments in the infrastructure of the ISS by using the ship "Progress".

Cosmonaut Training Center named Yu.A. Gagarin. Training of crew members of the ISS-29/30 A. Shkaplerov and A. Ivanishina with gym layout with TLC.

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Specificity of space experiments in the infrastructure of the ISS by using the ship "Progress".

Test out "Chibis-M" from the TLC on the vertical stand.

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OAO RSC "Energy". Bench testing exit "Chibis-M“ from the TLC and disclosures of solar panel in thermal-vacuum chamber at liquid nitrogen temperature.

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Specificity of space experiments in the infrastructure of the ISS by using the ship "Progress".

IKI, Moscow. Test "Chibis-M" for electromagnetic compatibility and susceptibility. Right vibration tests with TLC "Chibis-M".

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Specificity of space experiments in the infrastructure of the ISS by using the ship "Progress".

TLC loading in "Progress".

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Baikonur 2011. TLC "Chibis-M" on the conveyor frame in Progress M-13M".

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Specificity of space experiments in the infrastructure of the ISS by using the ship "Progress".

To complete the task output MC of the TLC a mechanism extension, providing an output "Chibis-M" from the TLC at a rate of separation of 0.2 m / s.
ISS RS. Cosmonauts O. Kononenko and A. Shkaplerov conduct preparatory work with TLC "Chibis-M".

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Specificity of space experiments in the infrastructure of the ISS by using the ship "Progress".

1. In the infrastructure of the Russian segment of the ISS scheme of microsatellites delivery into orbit are used.

"Kolibri-2000“
- $h = 380$ km
- Lifetime 48 days

"Chibis-M"
- $h = 513$ km
- Lifetime 960 days

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Space education.

School "Helios" IATE (Obninsk). Discussion of the scientific results of the project "Chibis-M". Right - the poster of the international conference on the events on the Sun 4-24 April 2002.

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January 25, 2012 microsatellite "Chibis-M" went out from the TLC on board the cargo spacecraft "Progress M-13M", located in the autonomous flight. The start was implemented in 3:18:30 msc.
Microsatellite “Chibis-M”  http://chibis.cosmos.ru

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2. Russian Academy of Sciences created the first microsatellite "Chibis-M", designed for space research on fundamental problems of high-altitude lightning discharges.
According to MCC-M data "Chibis-M" was put into orbit with parameters:

- The minimum height above the Earth's surface - 497.535 km;
- The maximum height above the Earth's surface - 513.607 km;
- Period - 94.55 min;
- Inclination - 51.62 degrees.

After separation of the "Chibis-M" decayed "Progress-M13" was provided in accordance with the flight program.
Main technical characteristics of the micro-satellite "Chibis".

**Mass**
- 40 kg.
  - Scientific instruments: 10.8 kg.
  - Service system: 18.2 kg.
  - Construction and temperature control system: 9.3 kg.

**Orbit**
- Circular ~ of 500 km.

**Orientation systems:**
- Types: electromechanical (electroflywheels), magnetodynamic (electromagnets), gravitational (boom);
- Accuracy of the determination of orientation: from the sensors (magnetic field, solar) and systems GPS - GLONASS, to 2-angl. deg.
- Accuracy of guidance: +/- 3 - 15 angl. deg.

**Data-transmission system:**
- S/C-Earth: 1 Mbit/s
- The capacity of onboard storage: 0.5 Gbytes
- The volume of the adopted from the board information: ~ 50 Mbayt/day

**Radio frequencies:**
- The radio frequency of command and service links: 145, 435 MHz.
- The radio frequency of telemetric link: 2200 MHz.
- The system of onboard power supply: 50 W

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Microsatellite “Chibis-M”  [http://chibis.cosmos.ru](http://chibis.cosmos.ru)
For the study of new physical processes in high-altitude atmospheric lightning discharges and mechanisms for their preparation requires a comprehensive study of gamma radiation, infrared and ultraviolet radiation, of electromagnetic waves in a wide frequency range with an unprecedented high (better share microseconds) time resolution.
Complex of scientific instruments “Groza”  - 10.8 kg.

- roentgen-gamma- detector [RGD] (NIIYaF) for registering the splashes of X-ray and gamma-radiation (range of photon energy 0.02-1.0 MeV);
- ultraviolet detector [DUF] (NIIYaF) for registering the splashes of the atmospheric of ultraviolet (wavelength range 180-400 nm) and red (650-800 nm) emissions;
- radio-frequency analyzer- register [RChA] (IKI) in the radio-frequency band (input frequency 26-48 MHz), analysis and registration on board KA of the electrical activity of the high-altitude lightning discharges;
- digital camera [DFK] (IKI) with the spatial resolution 300 m for observing the thunderstorm atmospheric discharges;
- magnetic- wave complex [MVK] (IKI, L'vov center IKD NANU-GKAU, Eotvos University, Budapest] for studying the electromagnetic parameters (frequency band 0.1-40 kHz) and the interrelation of plasma- wave processes in the ionosphere;
- accumulation of data [BND – Ch] (IKI) with the memory of two blocks on 256 Mbytes for the collection and primary information processing, which enters from the transmitter of scientific information from the complex of scientific instruments (IKI);
- transmitter at the frequency 2.2 GHz [IKI] with a speed of up to 1 Mbit/s and at the distance to 2500 km.

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Microsatellite “Chibis-M”  

http://chibis.cosmos.ru

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Each device “Groza” has a ring memory (RM) is a fixed size for multiple events.

Such a system for the first time in the world used to study the processes of lightning.

The total size of the memory device is determined by the maximum duration of the events of this instrument, which is set by directors of the experiment. Duration of the event can be controlled by commands. Example: RFA-1, RGD-20 ms, DUF-100 ms.
The fact of registration of the lightning discharge ("event") is to develop the “Groza" single trigger events based on coincidence triggers physical devices. Algorithms for generating these triggers are based on models of the physical mechanisms of lightning.
Microsatellite “Chibis-M”  http://chibis.cosmos.ru

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3. For the first time conducted at altitudes of 250 - 500 km. comprehensive studies of ultraviolet (UV) and infrared (IR) radiation, gamma rays, radio and ELF / VLF emissions in thunderstorm formations.

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4. For the first time simultaneously recorded signals in the UV and IR regions of the optical spectrum and radio emission in the range of 26-48 MHz. These data are necessary for the correlation analysis of the electric field and the efficiency of the plasma glow discharge of lightning.
5. Registered powerful microsecond VHF pulses - the result of runaway breakdown, which, more often, accompanied by repeated pulses, which is a reflection of the first surface of the Earth. The interval between the first and second pulses to determine the height of the discharge order of 10 km.

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6. Proved the existence in the upper ionosphere low-frequency electromagnetic structures excited by atmospheric thunderstorm activity: ionospheric Alfven resonator (frequency of about 0.5 Hz to ~ 5 Hz) and the Schumann resonance (~ 8 Hz frequency and harmonics).
Electromagnetic structures such as the Schumann Resonance or IAR, are an indispensable part of the cosmic environment of planets which have as Earth's ionosphere and signs of electrical storm activity (*Venus, Jupiter, Saturn, Neptune, et al.*).

Detection and study of these electromagnetic structures at the top of the Earth's ionosphere excited by lightning on LEO devices (such as "Chibis-M") makes it possible to use these experiments as a testing ground for the development of new methods for studying distant thunderstorm activity in the atmospheres of the planets of the solar system.
In the ionosphere unique data about the extremely low frequency (ELF) electric fluctuations, reflecting the impact of long transmission lines (50-60 Hz).
http://tm.chibis.cosmos.ru/chibis

Survey data plots representing teamwork devices and systems microsatellite "Chibis-M", please visit
Prospects on the MS in the infrastructure of the Russian segment of the ISS.

In the “Scientific and Application Program of the ISS Russian Segment” are included:


Prospects on the MS in the infrastructure of the Russian segment of the ISS.

Main parameters of the “Chibis-AI”

<table>
<thead>
<tr>
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<th>«Chibis-M»</th>
<th>«Chibis-Al»</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radio frequency analyzer</td>
<td>26-48 MHz, resolution &lt;10 ns</td>
<td>15-48 MHz, resolution &lt;10 ns</td>
<td>Two independent receivers with increased dynamical range</td>
</tr>
<tr>
<td>Roentgen-gamma detector</td>
<td>0.02-1.0 MeV</td>
<td>0.1-10 MeV (NGS)</td>
<td>Increased geom. Factor</td>
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Prospects on the MS in the infrastructure of the Russian segment of the ISS.

«Trabant»

Monitoring of space environment at frequency 0-100 MHz

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Thanks for the attention
Distinguished Colleagues
Development of discharge depending on the height

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VHF broadband "noise"

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