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Development of the Scientific Equipment for Search and Localization of Air Leak Places from the ISS ROS Pressurized Compartments

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Abstract: The article describes the main results of the development of the scientific equipment intended for refinement of methods of searching the air leaks from the ISS pressurized compartments. It should be stressed that in the process of work the hardware and software scientific complex, consisting of the optical-electronic unit, control and monitor pane,l and laptop, was designed. The optical-electronic unit is an extravehicular part of the complex used for identification of various effects and anomalies taking place at depressurization of the station. The results of measurements and video data are transferred via the panel to the onboard laptop in which indications of the UV, IR and visible band cameras, UV-spectrometer, as well as vacuum control and electric field intensity devices, are fixed. Moreover, separate parts of the scientific equipment have passed factory and interdepartmental tests and verified their working capacity. The design and engineering documentation for the scientific equipment was issued. It should be noted that the scientific complex will allow one to optimize the most effective method of extravehicular search of air leak places from the pressurized compartments of the ISS ROS (the Russian Orbital Segment of the International Space Station).

Keywords: air leak, depressurization, research, device, equipment

The off-nominal situation leading to air leaking from the station pressurized compartments, for example, at collisions of the International Space Station (ISS) with another vehicle, at blow of a large meteoric particle or because of the collision with the elements of space debris can take place during the ISS operation. By means of the scientific "BAR-ARM" equipment developed by Joint Stock Company "Scientific and Production Association of Measurement Equipment" ("NPO IT") the space experiment (SE) "Express" is carried out at the ISS. The purpose of the experiment is working off the methods of air leakage search from the ISS compartments.

The "BAR-ARM" equipment consists of the optical-electronic unit, monitor and control panel, and onboard laptop, on the display of which the indications of sensors and images received by means of optical devices of the equipment are shown.

The optical-electronic unit (OEU) is an extravehicular part of a complex of the scientific "BAR-ARM" equipment. A 3D model of the OEU is shown in Fig. 1. The OEU is intended for identification of various effects and anomalies on an external surface of the ISS taking place at air leakage into the external environment. Change of pressure of own external atmosphere of the ISS, change of the temperature field of an external surface, luminescence of gases and vapors of water in the ultraviolet range, and change of the electric field intensity can be such effects. To control these factors the OEU includes the following devices:

- TV camera of visible range;
- TV camera of infrared (IR) range;
- camera of ultraviolet (UV) range;
- UV range spectrometer;
- vacuum control system with two space-separated sensors;
- intensity measurement system of alternating electric field.

In the course of the experiment, the OEU will move along the ISS surface by means of the operated manipulator. Before the experiment, the equipment is transferred from the stand-by mode to the operating mode. The stand-by mode includes the storage mode of the scientific "BAR-ARM" equipment on the board and periodic tests. The thermal stabilization system, which is built in the OEU, is involved in this mode. The connection of the payload adapter, on which the OEU is placed, to the active docking adaptor of the manipulator and its transfer to the measurement zone is carried out while transferring

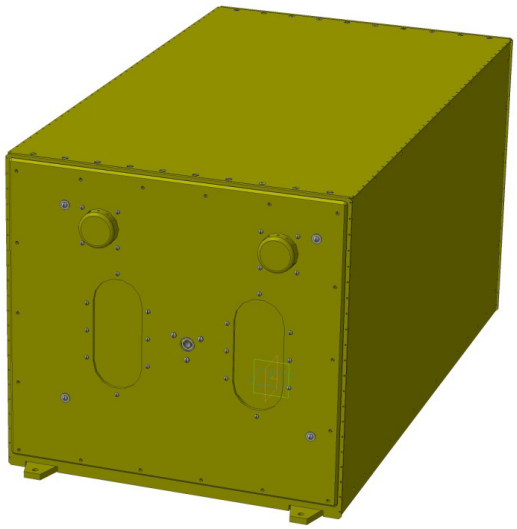

Fig. 1. The prototype of the optical-electronic unit (OEU) of the scientific "BAR-ARM" equipment.

the equipment to the operating mode. Then opening of protective shutters of the optical windows of the OEU modules and carrying out the measurement sessions by each scientific equipment module is implemented. Upon termination of a measurement session, the protective shutters are closed, and the manipulator transfers the OEU to a storage zone. The payload adapter is connected to the passive docking adaptor to activate the thermal stabilization system of the OEU while storage.

The optical devices "Thompson" and "SOM" (Fig. 2 and Fig. 3) are placed in the pressurized compartments (Fig. 4) and are packed in the OEU frame. To pass the optical radiation of visible, IR and UV ranges, the OEU frame is supplied with quartz and germanium entrance windows. The windows are equipped with blends (hoods) for protection against the side illumination. The entrance windows have the operated blinds for protection against the external pollution caused by products of orientation and correction engines operation.

The results of thermal and ultraviolet radiation control will be put on the image received by the TV camera of the visible range. The corresponding scientific software for this purpose is under development. The experiment results are output onto the on-board computer (laptop).

The interface of the on-board computer to the OEU devices is carried out via the intermediate control panel, where necessary devices of digital signal transformation are placed.

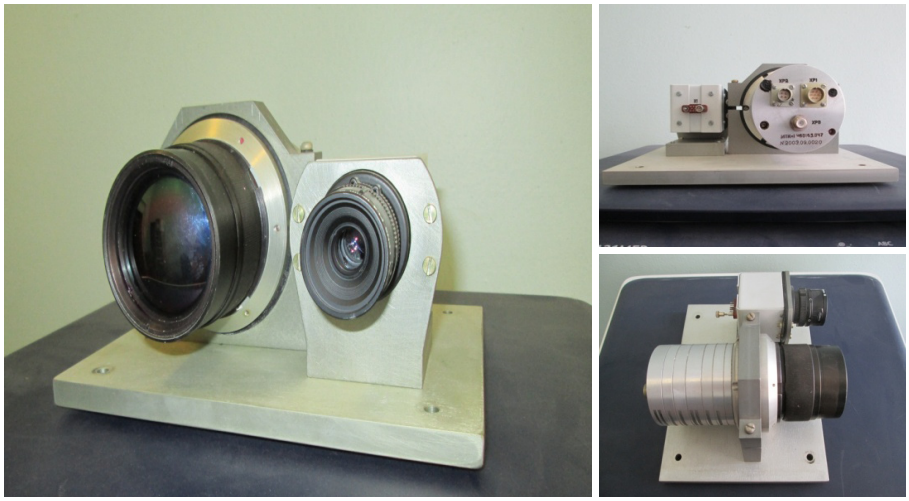

Fig. 2. A TV module “Tompson”

Fig. 3. A spectral optical module “SOM”

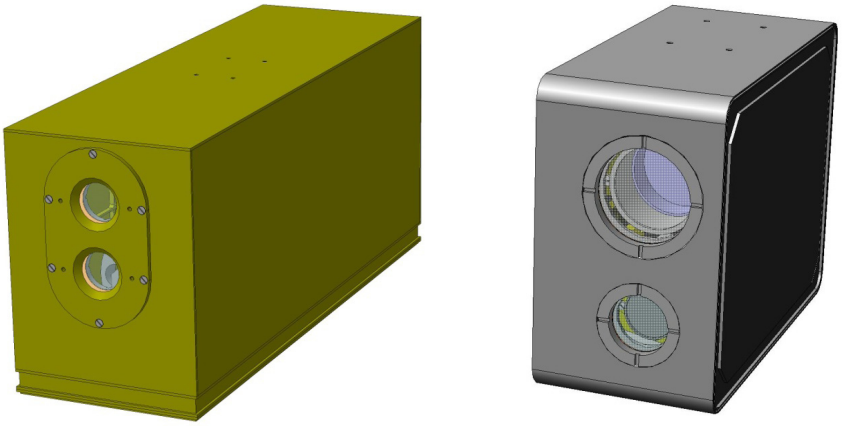

Fig. 4. Air-tight units of the optical devices to control the surface of the ISS in UV, IR and visible spectrum ranges.

Nowadays the components of the OEU and the "BAR-ARM" equipment are at various development stages. In particular, television modules of visible and infrared ranges have passed preliminary (factory) tests, and the vacuum monitoring system – interdepartmental tests.

The successful completion of the "BAR-ARM" equipment development will allow one to fulfill the most effective method of extravehicular search of air leakage places from the ISS pressurized compartments.

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