

49th STUDENT CONFERENCE (E2)  
Educational Pico and Nano Satellites (4)

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EXPERIENCE IN THE DEVELOPMENT AND OPERATION OF THE NANOSATELLITES FOR  
SPACE WEATHER MONITORING**Abstract**

Yareelo is an educational project of two CubeSats 1.5U, which scientific objectives are related to space weather researches. The payload on the Yareelo 1 spacecraft is an X-ray spectrophotometer developed by the LPI RAS. The sensor allows recording solar flares and coronal mass ejections in the X-ray range (0.5-15 keV). A gamma-ray and charged particle detector, developed by the SINP MSU, is installed as a payload on Yareelo 2 nanosatellite. The detector examines the rapid variations of electron fluxes in the gaps between the radiation belts, and studies the particle fluxes and gamma radiation dynamics in low orbits, in the range of 0.1-2 MeV.

The first stage of the preparation tests for flight was qualification tests. They included thermal vacuum tests for the temperatures cyclic effect and extreme temperatures. In September 2019 during mechanical loading tests, we confirmed the nanosatellites operability under shock, quasi-static, and vibration loads. As a result, the design documentation was corrected and the CubeSats design was completed. Then, tests were conducted for flight loading levels in a launchpad simulator.

In summer 2020, took place preparation for the launch stage. It included checks after the all systems assembly: VHF radio communication, onboard computer, power supply system, navigation receiver, orientation, and stabilization system based on the flywheels and magnetic coils. Power supply system tests, solar panels illumination, and the sensors calibration part were carried out. The payloads were integrated and climatic and mechanical acceptance tests were carried out. After fitting into the launchpad, the nanosatellites were ready for final assembly, fasteners contouring, and cleaning.

The launch of the Yareelo spacecraft was on September 28, 2020 from the Plesetsk space-center on Soyuz-2.1b rocket by the Universat program of Roscosmos Corporation. The final checks included: systems operability monitoring; setting the radio transmitters to the standard power, removing the payloads protective caps, turning on, and installing satellites inside the launchpad.

Now both Yareelo nanosatellites are in orbit. They are controlled by the Small Spacecraft Mission Control Center of the Bauman Moscow State Technical University. The transmit frequencies of nanosatellites are 435.35 and 435.55 MHz. After the first communication sessions appeared the task of improving the communication system. At the moment, reception is carried out using directional Yagi-Uda antennas

using the software-defined LimeSDR system. The equipment for sending commands: a transmitter with a preamp and a signal amplifier (400 W). Other service systems are being improved based on the results of flight.