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Solar gamma-ray spectrometers on MSU cubesats: experimental methodology and first results

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Gamma-ray scintillation spectrometers DeCoR (Detectors of Cosmic Radiation) developed in SINP MSU are installed on the small satellites Avion, Monitor-2, Monitor-3, Monitor-4 and UTMN-2 of the cubesat format, launched in June 2023 into a circular polar orbit with a height of ~550 km. They are designed to study hard x-ray and gamma radiation from solar flares as well as fast variations in near-Earth electron fluxes and astrophysical gamma-ray bursts. In the space experiment, several modifications of the device are used, differing in sensitive area and energy range. The detectors of the DeCoR-1 and DeCoR-2 devices are a combination of a plastic scintillator ~3 mm thick and a CsI (Tl) crystal ~10 mm thick allowing to distinguish between solar flares and electron precipitation. Their energy range is 0.05 – 2.0 MeV, the effective area is 18 cm^2 for DeCoR-1 and 64 cm^2 for DeCoR-2. The Avion and Monitor-2 satellites additionally have DeCoR-3 gamma-ray spectrometers based on a large CsI(Tl) crystal in order to register gamma-ray quanta of MeV energies.

The output data from all DeCoR devices are generated both in the form of monitoring (the counting rate in several channels corresponding to a certain type of particles and energy) and in the form of a detailed recording in an event-by-event format, when for each case of interaction in the detector, a set of amplitudes and the exact time with a resolution of ~ 1 microsecond are recorded. The data is stored in the non-volatile memory of the payload, then it can be transmitted either directly to the satellite radio transmitter or to the memory of the on-board computer. Thus, during the space experiment, it is possible to select the most important data sections for transmission to Earth in primary form, which allows for studies of the rapid variability of the measured radiation fluxes.

At the present moment, the methodology of a space experiment using DeCoR equipment has been worked out during flight tests, taking into account the information and energy capabilities of small satellites, and device settings have been optimized. For several months a hard radiation from a number of solar flares was recorded and solar cosmic rays were also observed. It is planned to continue the experiment on the satellites listed above in the next 1-2 years, as well as to launch several new nanosatellites with similar equipment.