RELEC Space Mission for Relativistic Electron Precipitation and TLE study

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A set of scientific instruments RELEC was prepared for space experiment onboard a small satellite by Moscow State University and several other organizations from Russia, Hungary, Ukraine, Poland and South Korea. The RELEC experiment was specially developed for study of relativistic electrons in near-Earth space together with TLEs in order to test possible connection between these two phenomena. RELEC mission includes x-ray and gamma-ray spectrometer, 3-axis detector for electrons, UV and red-light flash detector, fast optical imager, low-frequency and radio-frequency analyzers of electromagnetic field and waves. Data from RELEC mission will be processed for testing TLE models, studying of TGFs light curves and spectra, testing possible connection between electron precipitations and low-frequency electromagnetic waves. The launch of RELEC mission is scheduled on summer, 2014.

1. RELEC space mission

A small satellite with RELEC payload will be launched in summer, 2014 to quasi-circular solar-synchronous orbit with about 700 km height. The payload with mass ~40 kg is specialized for studying of near-Earth electrons and TLE phenomena [1]. Simultaneous measurement of electromagnetic, optical, x-ray, gamma radiation and charged particles will be provided by a number of instruments designed in Moscow State University and its collaborators. The collaboration members of RELEC are:

- Skobel'tsyn Institute of Nuclear Physics, Moscow State University. Moscow, Russia (project header company, x-ray, gamma and electron spectrometers, UV and optical flash detector)
- Space Research Institute, Russian Academy of Science, Moscow, Russia (electromagnetic field measurements)
- Institute of Space Research, Ukrainian Academy of Science and National Space Agency, Lviv, Ukraina (electromagnetic field sensors)
- Etvos University, Budapest, Hungary (low frequency electromagnetic field spectrum analyzer)
- Space Research Centrum, Poland Academy of Science, Warsaw, Poland (radiofrequency analyzer)
- Department of Physics, Sungkyunkwan University, Suwon, Korea (imaging UV and optical fast telescope)
- Aerospace Instrument Research Laboratory, Kaluga, Russia (control and information unit)
- Lavochkin Space Corporation, Hymki, Russia (spacecraft)

2. Scientific goals of RELEC

The main goal of RELEC mission is studying of magnetosphere relativistic electron precipitations and their acting on the upper Atmosphere as well as transient luminous events (TLE) observation in wide range of electromagnetic spectrum.

During the RELEC mission following experiments will be provided:

- simultaneous observations of energetic electron and proton flux (energy range ~0.1-15.0 MeV for electrons) and low-frequency (~0.1-10 kHz) electromagnetic wave field intensity variations with high temporal resolution (~1 ms);
- fine time structure (~20 mcs) measurements of transient atmospheric events in UV, X- and gamma rays together with optical imaging with spatial resolution of ~5 km in wide FOV;
- measurements of electron flux pitch-angle distribution in dynamical range from ~0.1 up to 10^5 part/cm^{2}s;
- monitoring of charged and neutral background particles in different areas of near-Earth space.

3. Instrumentation

The RELEC set of instruments includes a wide number of detectors and sensors for various particles and radiation:

- DRGE-1 and DRGE-2 are two identical spectrometers for x-rays and gammas. Each of them includes two independent scintillator phosvich X- and gamma-ray detectors of high temporal resolution (~15 mcs in event mode) and sensitivity. Total effective area is ~500cm^2 (for 100 keV). Energy range is 10-3000keV.
- DRGE-3 is a spectrometer of charged particles. It contains three axe directed complex scintillator detectors of energetic particles. Energy range of DRGE-3 for electrons is 0.1-15 meV, sensitive area of each detector is ~3 cm^2.
- DUV is a detector of fast UV (300-400 nm) and red-light flashes. Time resolution in standard mode is 1 ms. FOV of DUV is ~ Similar instruments successfully worked onboard microsatellites Tatyana, Tatyana-2 and Chibis [2][3].
- UV and optical pin-hole like imager Telescope-T (MTEL-2) is designed for fast imaging and spectral analysis of TLE light flashes. Space resolution of the instrument with ~11° FOV looking at the atmosphere from the orbit is 5 km x 5 km. Similar instrument named MTEL successfully worked onboard microsatellite Tatyana-2.
- low-frequency analyzer NChA (LFA) consists of two orthogonal sensors measuring electromagnetic field, two magnetometers (ferrozond and induction) and unit of spectral analysis. The instrument can measure the electric field in ULF range (from DC to 100 Hz) and in VLF one (from 10 Hz to 40 kHz) as well as 3-components of magnetic field (from DC to 40 kHz) and plasma current. Sensors are placed on a boom ~2m far from the satellite body. Instrument similar with NChA/RELEC successfully works onboard Chibis microsatellite [3].
- radio-frequency analyzer RFA measures 3 components of electric field in frequency range from 50 kHz to 15 MHz. Frequency resolution is 10 kHz, time resolution is 25 ns. Data can be collected in spectral or wave-form mode.
- module of electronics intended for commands and data collection BE.

4. Mission status

Now all of RELEC instruments are installed on-board small spacecraft manufactured by Lavochkin space corporation. The launch is scheduled on summer, 2014. Ground facilities are ready to control the satellite and its payload during spaceflight as well as to receive, to store and to process the scientific data. Total amount of transmitted data from RELEC mission is about 1.2 Gbyte per day.

4. References

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