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Author: Prof. Lee Jik
Korea, Republic of

Dr. G. Garipov
Russian Federation
Prof. Y.K. Kim
Korea, Republic of
Dr. B. Khrenov
Russian Federation
Prof. C.-H. Lee
Korea, Republic of
Prof. Jiwoo Nam
Research Center of MEMS Space Telescope, Korea, Republic of
Prof. Shinwoo Nam
Ewha Womans University, Korea, Republic of
Prof. Il H. Park
Ewha Womans University, Korea, Republic of
Dr. Jae-Hyoung Park
Korea, Republic of
Prof. Y.-S. Park
Korea, Republic of

A NEW TYPE OF SPACE TELESCOPE FOR OBSERVATION OF TERRESTRIAL TRANSIENT LIGHTS INCLUDING EXTREME LIGHTNING IN THE UPPER ATMOSPHERE

Abstract

Extreme lightning in the upper atmosphere called Transient Luminous Events (TLEs), are considered as the newly found component in the global electrical and chemical aspects of Earth and its atmosphere. The observation of space-time development of TLEs with high lateral resolution and fast time resolution, especially in the nadir direction, will provide a clue for understanding the formation mechanism of TLEs, and therefore their origin. We have proposed a novel space telescope equipped with a fast tilting MEMS (Micro-Electro-Mechanical Systems) micromirror array and MAPMT (multi-anode photomultiplier tube) photo-detectors. The fast tilting of the MEMS micromirror array and the fast response of the photo-detectors to lights make the telescope capable of observing the space-time development of TLEs with a fast time resolution.

We have realized the concept of the new telescope into MTEL (MEMS Telescope for Extreme Lightning) which has the unique feature of wide field view monitoring, fast tracking and zoom-in capability. MTEL consists of three subcomponents: Trigger telescope (T1), Zoom-in telescope (T2), and Spectrophotometer (S3). T1 is a pin-hole like camera which watches down the earth with the area of 160 km x 160 km with a resolution of 20 km x 20 km. T2 consists of 64 cell 2-axis analogue rotatable micromirror array to zoom a TLE event triggered by T1. The resolution of T2 is 5 km x 5 km. S3 has 8 different filters in front of a wide wavelength sensitive 64 channel MAPMT. The weight of MTEL is 4.5 kg, and its overall dimension is 520 mm x 144.5 mm x 142 mm. The size of MTEL data to transfer during a 24-hour

period from MTEL to the onboard computer is 400 Mbit. The data stored at the onboard computer will be transferred to the ground at the rate of 500 kbits/sec during the time window allowed for the telemetry. Various commands to control MTEL can be sent to the satellite from the ground at the rate of 1.2 kbits/sec during the time window allowed for the telemetry.

MTEL has successfully finished all space qualification tests including electromagnetic compatibility test, shock and vibration test, and thermal vacuum test, humidity test, etc., and is being integrated into the Russian microsatellite Tatiana-2. After launch in the middle of this summer, the payload of MTEL will observe terrestrial transient lights including TLEs at the orbit of 800 km in space for three years.