# Current status of development of multi-spectral auroral camera on the LAMP rocket experiment

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We report the current status of development and future plan of the multi-spectral auroral camera (AIC2) installed on the LAMP rocket which will be launched at Pokar Flat, Alaska in this winter period. Recent Arase satellite observations have revealed that chorus waves cause the pitch-angle scattering of several keV electrons, which produce pulsating aurora, near the magnetic equator. The chorus waves are theoretically thought to cause the pitch angle scattering of electrons in a wide energy range from several keV to MeV. Microburst is a high-speed modulation of MeV electrons at 1 Hz or higher and is generated by electron resonance with a chorus wave. Therefore, the positive relationship between pulsating aurora and microbursts is expected. However, there is no simultaneous observation between them. The purpose of the LAMP rocket is to clarify the relationship between pulsating aurora and microbursts with simultaneous particle, electromagnetic waves and imaging measurements. The project PI is Dr. Jones of NASA/GSFC. The instrumental package called PARM2 (Pulsating AuRora and Microburst 2) is provided by a Japanese team. AIC2 is a one of PARM2 which consists of two CMOS detectors called AIC-S1 and S2, and the data processing electrics AIC-E, and it will perform auroral imaging at two wavelengths simultaneously. AIC2 is characterized by a low noise (1.6 e-RMS) and wide dynamic range sampling capability (16bit A/D) using the consumer CMOS sensor (ZWO AS1183MM). AIC-S1 targets the N2 1PG aurora in the E region with the interference filter (Andover, CW 670 nm, FWHM 20 nm) and a fast objective lens (SpaceCom JF17095M, f= 17 mm. F/0.95, field of view 29 deg x 29 deg). AIC-S2 is designed to observe the OI 844.6 nm aurora in the F-region with an interference filer (Andover, CW 846 1 mm, FWHM 4.4 nm) and a wide-angle objective lens (SpacaCom HF3.5M-2, f= 3.5mm, F/1.6, field of view 106 deg x 106 deg). To gain S/N and reduce data size, binning is performed from an original 3660 pix x 3600 pix image to 60 bin x 60 bin (1bin=60pix x 60pix) image. AIC2 is mounted on the despun platform of the rocket to cancel a rocket spin. Combining the despun platform with the rocket attitude control, AIC-S1 will point to the magnetic footprint to observe the fine structure of pulsating aurora. AIC-S2 will point slantingly west to obtain the height profile of O 844.6 nm emission as well as the pulsating auroral distribution in the wide range. The time resolution of each camera is approximately 10 frames/s. At the apex altitude (~450km), the spatial resolution at nadir is 3.0 km x 3.0 km for AIC-S1 (the E-region), and 6.3 km x 6.3 km for AIC- S2 (the F-region). The AIC-E consists of two NanoPiM4V2 board computers, two FPGAs, and power supply to handle a large amount of image data produced by the two cameras. We use a heat pipe unit to cool the two CPUs of NanoPiM4V2. Total weight and power of AIC2 are 2.6 kg and 20 W, respectively. On the development of AIC2, we carried out the following tests: 1) time accuracy of image sampling, 2) sensitivity calibration, 3) data communication via rotational terminal of despun platform, 4) thermal vacuum test with the heat pipe, 5) focus adjustment, and 6) electrical interface between AIC-S1, S2 and AIC-E. As a result, 1) the time accuracy is 0.1 ms, which is sufficient to observe the internal modulation (~3 Hz) of pulsating aurora, 2) the dynamic range is 0-480 kR AIC-S1 and 0 - 360kR - for AIC-S2, 3) no data error happed via despun platform, 4) AIC operated normally in the vaccum conditions with temperatures of 0,10,20 ˚C for more than 30 minutes, and the heat pipes worked as designed, 5) focus adjustment was made with sims. On 6), there was an issue that the USB 3.0 connection between Nanopi M4V2 and ZWO camera electronics. To solve this, we improved the software to modify the

 

initialization of the Nanopi M4V2, and the timing of camera detection.

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