LIR onboard Venus Climate Orbiter

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LIR images the Venusian atmosphere with the longest wavelength among a suite of imagers onboard the Japanese first Venus mission PLANET-C or Venus Climate Orbiter. LIR measures thermal radiation emitted from the cloud-top of the Venusian atmosphere. A horizontal wind vector field at the cloud-top height (~70km) will be retrieved by cloud tracking, which is accomplished by means of spatial correlation between cloud-top temperature anomalies detected in successive images. Absolute temperature will be also determined with an accuracy of 3K. Since solar irradiation scattered by the atmosphere is much weaker than the atmospheric radiation, LIR can continuously provide a hemispheric wind field independent of local time of the apocenter which will go around the planet three times during the mission life. Wind and temperature fields obtained by LIR will provide key parameters to solve climatological issues on the Venusian atmosphere.

LIR comprises a lens system including an optical band-pass filter, a hood, a mechanical shutter, an infrared focal plane array sensor, and a driving circuit. Use of an uncooled microbolometer array (UMBA) which needs no cryogenic apparatus contributes to reduction of power and weight of LIR. The UMBA is arranged as a 320x240 array of 37 um square pixels, but 240x240 pixels are used. The instrumental field-of-view of 12 degree is equal to the angle subtended by Venus when observed from a nominal height of the apocenter of 10 Rv. The pixel field-of-view of 0.05 degree corresponds to a spatial resolution of 70 km. The sensitive spectral region is limited by passband of the filter to 8-12 um. The mechanical shutter functions not only as an optical shutter but also as a reference blackbody. Temperature stability of the UMBA package, the housing, the optics and the shutter is especially important for reduction of background noise due to fluctuation of thermal radiation from the environment and for precise calibration of sensitivity. Temperature of the UMBA package is stabilized at 313+/-0.1K with a Peltier cooler/heater. NETD of 0.3K, which is required for the scientific purpose, will be achieved. Robustness of the UMBA against radiation was evaluated by an experiment with a 100 MeV proton beam. It is confirmed that number of pixel defect did not change after total dose of 30 kRad with fluence of 400 Rad/min.

A thermal infrared image is created by accumulation of 30 frames during 1 sec. Flat field images with the shutter closed are taken several seconds before and after exposure for a Venus image. After a Venus image is taken, LIR takes a cold calibration image of deep space. This measurement sequence is repeated every two hours while the spacecraft is in the apocenter part of the orbit. The depth of an image is 12 bits. Image data are transmitted down to the Earth after onboard calibration and data compression by a common digital electronics.

Latest status of designing the optics, mechanics, electronics and thermal structure of LIR and results of performance tests using an experimental model will be presented.