LIR onboard Venus Climate Orbiter - Development of a Proto Model

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PLANET-C or Venus Climate Orbiter is equipped with a suite of imagers that depict emission patterns in several layers in the atmosphere and on the ground of Venus. The Longwave Infrared Camera or LIR is an imager operating in the middle infrared region measuring thermal radiation emitted from the cloud-top of the Venusian atmosphere. A horizontal wind vector field at that height will be retrieved by means of a cloud tracking method. 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. 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. The UMBA is arranged as a 240x240 array of 37 um square pixels. The instrumental field-of-view of 12deg is equal to the angle subtended by Venus when observed from a height of 10 Rv. The pixel field-of-view corresponds to a spatial resolution of 50 km. The sensitive spectral region is limited by a band-pass filter to 8-12 um. The shutter functions not only as an optical light blocker but also as a reference blackbody. Temperature stability of the sensor is especially important for reduction of background noise due to thermal radiation from the environment and precise sensitivity calibration. Temperature of the UMBA package is stabilized at 313+/-0.1K with a Peltier cooler/heater. It is expected that NETD of 0.3K, which is required for the scientific purpose, can be achieved as a result of a careful examination of image data obtained by a BBM and improvements in the electrical circuit design. Radiation tolerance of the UMBA was evaluated by an experiment with a 100 MeV proton beam. It is confirmed that number of pixel defect unchanged 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. LIR sometimes acquires 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.

Manufacture of the proto model of LIR will be finished by the end of May, 2007. Then it will be under mechanical testing. Following that NETD, accuracy in absolute temperature measurement and flatness of the sensitivity will be checked using a cold black body in a vacuum chamber, and FOV, MTF and stray light will be measured using an artificial star and a rotating and tilting stage. In parallel an accelerated endurance test of the shutter mechanism will be performed in a vacuum chamber in May and June. A thermal vacuum test is scheduled in October after the system electrical interface and function test.