UNCOOLED THERMAL INFRARED CAMERA DEVELOPMENT AT JHU-APL. C. A. Hibbitts, J. D. Boldt, S. X. Liang, W. K. Edens, M. A. Kelly, R. E. Erlandson, E. H. Darlington, Johns Hopkins University Applied Physics Laboratory, 11100 Johns Hopkins Rd., Laurel, Md. 20723, 443-778-2834, karl.hibbitts@jhuapl.edu.

Introduction: The application of a large format uncooled thermal imager is potentially as large and varied as an optical camera. These cameras are compact, low powered and with recent advances in uncooled detector technology, megapixel formats are now available, enabling large format high resolution imaging in the thermal infrared with an uncooled detector. Fundamental science and engineering goals can benefit from such a low-powered, compact thermal infrared camera and several current and past missions have successfully used similar detector technology such as the MGS THEMIS instrument [1]. Thermal imaging offers unique measurement capabilities, including the ability to image shadowed surfaces to obtain a full shape model without being reliant on solar reflectance; measuring surface temperature; as well as determining intrinsic physical properties such as thermal inertia. Although these detectors are less sensitive than cryocooled photon counters (such as HgCdTe arrays), they can potentially be utilized for spectroscopy on warm planetary surfaces from the Moon, NEO's, and Mercury [2].

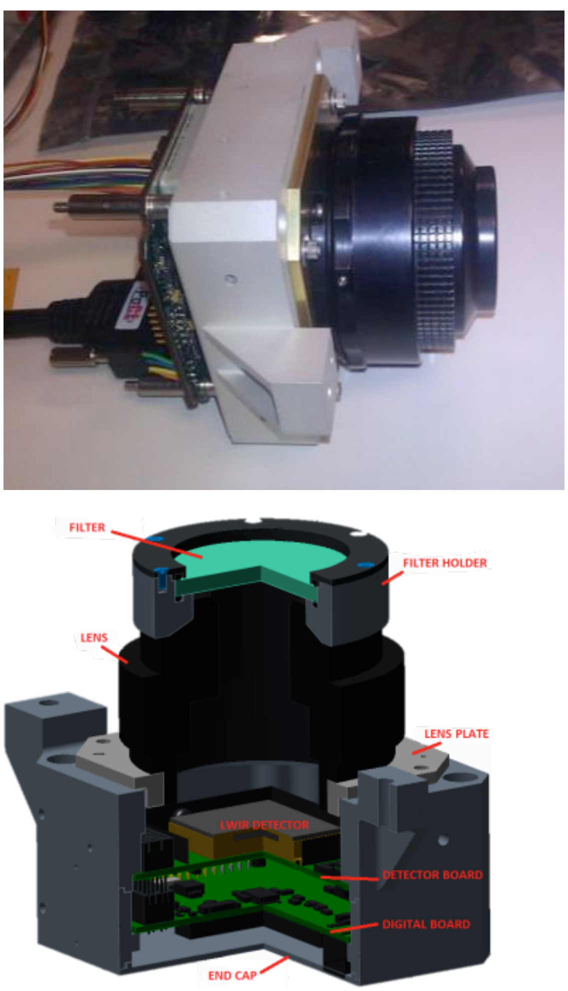

Figure 1. Photograph and cut-away of view of the APL LWIR camera.

Development: We have developed an LWIR Camera shown in Figure 1 based on the ULIS UL05251-026 amorphous silicon MEMS microbolometer array with 1024×768 pixels, 17-µm pixel pitch, spectral response from ~7.5 to 14.5 µm (limited by a filtered window integral to the detector), and nominal broadband sensitivity of 60 mK for a 300 K scene. Custom electronics were developed to support the ULIS detector and allowed operation at up to 30 frames per second. The electronics assembly was integrated with ruggedized COTS refractive optics for a series of high-altitude aircraft data collection flights. A stable temperature of 15°C was maintained in the cold environment at altitude through the use of heaters and temperature sensors applied to the exterior of the camera body and COTS optics. A sliding suite-level aperture door, whose temperature was monitored, acted as both a periodic flat-field and radiometric calibration source during flights and as a protective cover. The ULIS UL05251-026 microbolometer array was also tested for total ionizing dose (TID) radiation tolerance during 2011 using APL's ^{60}Co γ-irradiation facility. Results of this testing indicate that device performance is maintained to a dose of ~30 krad with the device powered and operational. Modeling and flight measurements demonstrate the ability of this camera to detect surfaces in 1-µm bins at temperatures as low as 200K, and cooler unfiltered.

The electronics board size can be reduced from 3.5 x 3.5 in. to 3.25 × 3.25 in. The housing is constructed using a minimum thickness of 100 mils of aluminum to provide radiation shielding. To allow precision control over placement of the detector in relationship to the optics, a flexurized detector carrier can be employed in conjunction with a rigid- flex printed circuit board. In future camera iterations, an internal shutter mechanism can replace the external shutter. Additionally, the filtered window that covers the detector can be removed or the detector delivered without a filtered window for enabling response both above and below the current spectral range. For a spaceflight version of the LWIR Camera, the COTS optics would be replaced with custom optics using radiation-tolerant materials and designed to the specific spatial coverage requirements of the mission.

References: [1] Christensen, P.R. et al., Space Science Reviews, 110: 85-130, 2004. [2] Arnold et al., Proc. SPIE7808, IR Remote Sensing and Instr. XVIII, 78080I; doi: 10.1117/12.860144, 2010.