Thermal Modeling of the OSIRIS-REx Camera Suite (OCAMS)

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OSIRIS-REx is an asteroid sample return mission, led by scientists at the University of Arizona, that will send a spacecraft to a near-Earth asteroid for the purpose of collecting a sample and returning it to Earth for testing and analysis. The purpose of the mission is to collect a sample from a carbonaceous asteroid, named Bennu, that contains organic matter representative of what was present during the formation of the solar system. We also hope to better understand the origin of objects like Bennu. This will allow scientists to better understand how life formed in the solar system and to better interpret ground-based observations of asteroids like Bennu. There are several scientific instruments placed on the spacecraft to help accomplish this mission, including the OSIRIS-REx Camera Suite (OCAMS), developed by engineers and scientists at the University of Arizona. OCAMS is comprised of three different visible light cameras (MapCam, SamCam, and PolyCam) which will acquire images of Bennu at ranges from 2 million km to a few meters from the surface. OCAMS will characterize the surface and shape of the asteroid and help locate and take images of the sample site and sample acquisition.

Thermal models of each of the three OCAMS cameras for the OSIRIS-REx mission were developed in Thermal Desktop and solved with SINDA/FLUINT. Since these models needed to be incorporated into a system-level spacecraft thermal model along with all of the other OSIRIS-REx instrument thermal models, each model had a node count limit of roughly 100 nodes. They were developed largely from the ground up, using mostly Thermal Desktop primitives and user-defined nodes. They were initially compared with detailed and independently-developed finite element models of the OCAMS cameras, and then correlated to thermal test data attained from Thermal Balance tests performed with OCAMS flight-like hardware.

Once these models were developed and correlated to test data, they were submitted to the spacecraft design team at Lockheed Martin, where they were incorporated into the system-level Thermal Desktop model of the space craft. It used heating environments and orbits within Thermal Desktop that incorporated the temperature model of Bennu, developed by OSIRIS-REx asteroid scientists, and trajectories that accurately simulated the maneuvers that the spacecraft will make as it approaches the asteroid. Temperature predictions at critical locations for each instrument were published allowing instrument engineers a better understanding of the temperatures experienced by the instruments during the mission. Spacecraft orbital heater power consumption was predicted while instruments were powered off. Thermal balance tests were also conducted at the space craft level, with all of the instruments installed and incorporated, and this test data was compared with system-level thermal model data as well.

An image of the three correlated 100-node models of OCAMS is shown in Figure 1. A more detailed thermal model of PolyCam is shown in Figure 2.

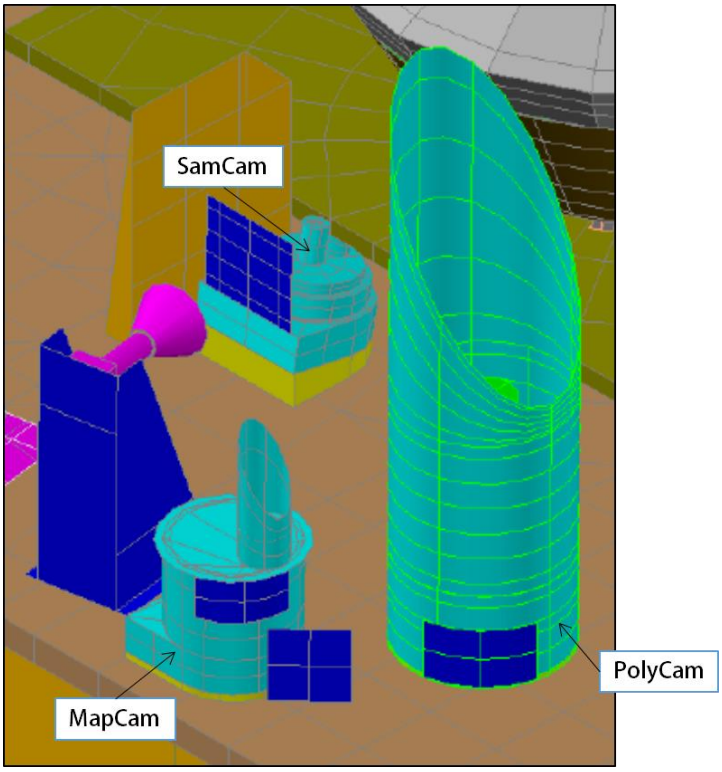

Figure 1: OSIRIS-REx Camera Suite (OCAMS) Thermal Desktop models

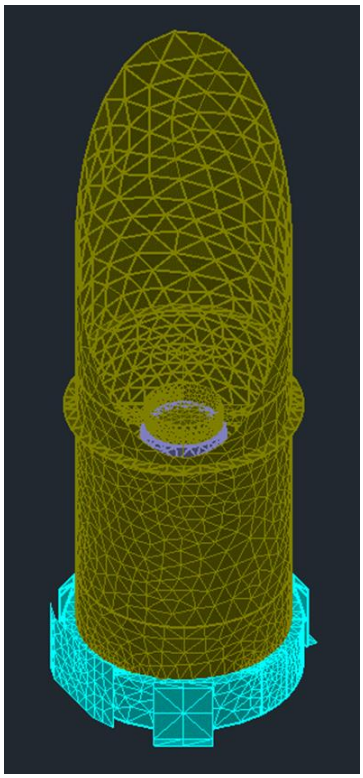

Figure 2: Detailed Thermal Desktop model of PolyCam