

OVERVIEW AND PERFORMANCE OF THE LOFTID INSTRUMENTATION SUITE. G. T. Swanson¹, C. D. Kazemba¹, R. A. Miller¹, H. S. Alpert¹, J. D. Williams², S. J. Hughes³, F. M. Cheatwood³. ¹NASA Ames Research Center, ²AMA Incorporated at NASA Ames Research Center, ³NASA Langley Research Center.

Brief Presenter Biography: Greg works on various projects as part of the Entry Systems and Vehicle Development Branch at NASA Ames Research Center and was the Instrumentation Lead for the LOFTID flight demonstration project. Greg received his Bachelor of Science and Master of Science degrees in Electrical Engineering from the University of Idaho.

Introduction: NASA's Hypersonic Inflatable Aerodynamic Decelerator (HIAD) is an enabling technology that facilitates atmospheric entry of heavy payloads to planets such as Earth and Mars using a deployable aeroshell. The deployable nature of the HIAD technology allows it to overcome the size constraints imposed on current rigid aeroshell entry systems. This enables use of larger aeroshells resulting in increased entry system performance (e.g. higher payload mass and/or volume, higher landing altitude at Mars) [1].

On November 10th, 2022 the Low-Earth Orbit Flight Test of an Inflatable Decelerator (LOFTID) was launched out of Vandenberg Air Force Base as a secondary payload on an Atlas V rocket. After the primary payload was delivered to its orbit, the LOFTID reentry vehicle was inflated, positioned, and then separated to reenter Earth's atmosphere at a velocity of 8.1km/s, ultimately splashing down safely in the Pacific Ocean. The flight successfully demonstrated a 6m diameter, 70-deg sphere-cone HIAD on a high-energy orbital reentry. This demonstration has provided invaluable flight data essential to characterize the vehicle performance and support the ongoing effort to further scale the HIAD technology to vehicles of 10m in diameter or greater. Aeroshells of this scale are applicable to near-term commercial applications and future NASA robotic and human exploration missions.

LOFTID incorporated an extensive instrumentation suite totaling over 150 science measurements. This included thermocouples, total heat flux sensors, and a radiometer to characterize the aeroheating environment and aeroshell thermal response. An Inertial Measurement Unit (IMU), Global Positioning System (GPS), and flush air data system was included to allow post-flight reconstruction of the vehicle trajectory including a decoupling of the aerodynamics from the atmospheric density. Loadcells were used to measure HIAD structural response during entry, and cameras (both visual-spectrum and infrared) were mounted on the aft segment looking at the aeroshell to monitor

structural deflection and surface temperature distribution. Finally, a single up-look camera was included which has provided a surprising amount of science potential from the spectacular footage.

In addition to the primary instrumentation suite, a new Fiber Optic Sensing System (FOSS) was used to provide global temperature distributions as a technology demonstration. The system provided over 200 thermal measurements creating a thermal map for the backside of the nose Flexible Thermal Protection System. Another pair of FOSS cables were run along the rigid center structure and measured the temperature response to the vehicle wake environment. The LOFTID instrumentation suite leveraged Agency-wide expertise, with hardware development occurring at Ames Research Center, Langley Research Center, Marshall Space Flight Center, and Armstrong Flight Research Center.

This presentation will discuss the instrumentation selected for LOFTID to capture the HIAD performance during the high-energy orbital reentry flight test, provide examples of data products, and snippets of the spectacular reentry video.



Fig 1. Thermocouples and Heat Flux Gages Integrated with LOFTID Nose Insulation.



Fig 2. FOSS Installed between Insulation Layers on LOFTID Nose.

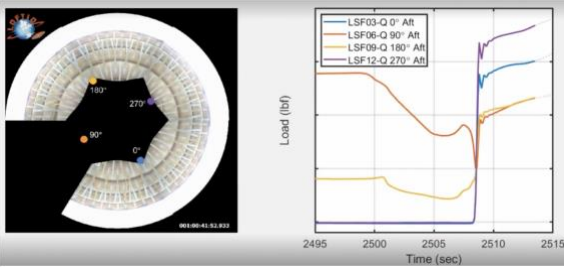


Fig 3. Screenshot of Loadcell Pin Data Sync'd with Entry Video



Fig 4. Screenshot of Up-look Camera Video During Reentry Showing Recompression Shock

References: [1] Cheatwood F. M. et al., IEEE Aerospace Conference, 2016