INTERDISCIPLINARY SESSION TOPICS

Interdisciplinary Session (Wednesday 1:00PM to 5:00PM)

Time	ID	Title	Author(s)	Affiliation	Email
1:00PM	TFAWS2012-IN-01	Computational Fluid Dynamics (CFD) Analysis of Optical Payload for Lasercomm Science (OPALS) Sealed Enclosure Module	Dr. Kevin R. Anderson Daniel Zayas Daniel Turner	JPL California State Polytechnic University at Pomona	Kevin.r.anderson@jpl.nasa.gov
1:30PM	TFAWS2012-IN-02	Regeneratively Cooled Rocket Nozzle CFD Cooling System Analysis	Matt Devost	California State Polytechnic University at Pomona	medevost@csupomona.edu
2:00PM	TFAWS2012-IN-03	Thermal Vacuum Testing: Methods of Thermal Conditioning in a Vacuum Environment	Michael McCullar	JSC	Michael.McCullar-1@nasa.gov
2:30PM	TFAWS2012-IN-04	Dawn Thermal Challenges While Operating at Vesta	Eric Sunada for Dr. Juan Cepeda-Rizo	JPL	Juan.Cepeda-Rizo@jpl.nasa.gov
3:30PM	TFAWS2012-IN-05	Opals Mission Thermal Design Study	Daniel Zayas	JPL	Daniel.A.Zayas@jpl.nasa.gov
4:00PM	TFAWS2012-IN-06	Thermal and Alignment Analysis of the Instrument-Level ATLAS Thermal Vacuum Test	Heather Bradshaw	GSFC	Heather.n.bradshaw@nasa.gov
4:30PM	TFAWS2012-IN-07	A System Analysis Demonstration Using Cielo	Mike Chainyk Greg Moore	JPL	Mchainyk@jpl.nasa.gov

TFAWS2012-IN-01

COMPUTATIONAL FLUID DYNAMICS (CFD) ANALYSIS OF OPTICAL PAYLOAD FOR LASERCOMM SCIENCE (OPALS) SEALED ENCLOSURE MODULE

Dr. Kevin R. Anderson, P.E., Jet Propulsion Laboratory, California Institute of Technology, and California State Polytechnic University at Pomona
Daniel Zayas, Jet Propulsion Laboratory, California Institute of Technology
Daniel Turner, Jet Propulsion Laboratory, California Institute of Technology

ABSTRACT

Computational Fluid Dynamics (CFD) using the commercial CFD package CFDEGIGN 2011 has been performed at NASA JPL in support of the Phaeton Early Career Hire Program's Optical Payload for Lasercomm Science (OPALS) mission. The OPALS project is one which involves an International Space Station payload that will be using forced convection cooling in a hermetically sealed enclosure at 1 atm of air to cool "off-the-shelf" vendor electronics. The CFD analysis was used to characterize the thermal and fluid flow environment within a complicated labyrinth of electronics boards, fans, instrumentation, harnessing, ductwork and heat exchanger fins. The paradigm of iteratively using CAD/CAE tools and CFD was followed in order to determine the optimum flow geometry and heat sink configuration to yield operational convective film coefficients and temperature survivability limits for the electronics payload. Results from this current CFD analysis and correlation of the CFD model against thermal test data will be presented. Lessons learned and coupled thermal / flow modeling strategies will be shared in the paper presented at TFAWS-2012.

TFAWS2012-IN-02

REGENERATIVELY COOLED ROCKET NOZZLE CFD COOLING SYSTEM ANALYSIS

Matt Devost, California State Polytechnic University at Pomona

ABSTRACT

The use of computational fluid dynamics (CFD) software in the design stages of various industries has proven to be a valuable and resourceful tool. Medical, mechanical and aerospace, are but just a few industries actively involved using CFD software to analyze prototype innovations before production. Using CFD software allows the manipulation of various physical parameters to simulate a working environment or even worst case conditions. Siemens offers a product lifecycle management tool known as NX. In this poster, the use of SIEMENS NX thermal/flow was used as a preliminary design tool to analyze the thermal cooling potential and fluid flow for the cooling fluid inside of a regeneratively cooled rocket nozzle. The results of the initial CFD analysis lead to a redesign of the cooling chamber and an overall improved cooling design for the high temperatures induced during a live fire of a rocket nozzle.

TFAWS2012-IN-03

THERMAL VACUUM TESTING: METHODS OF THERMAL CONDITIONING IN A VACUUM ENVIRONMENT

Michael McCullar, Johnson Space Center

ABSTRACT

This is the second paper in a series written by Michael McCullar on the subject of thermal vacuum testing of space hardware. The first paper titled "Thermal Vacuum Testing: Test Preparation" was written to provide general guidelines to follow when testing space hardware in a thermal vacuum environment. This current paper will go into greater detail on the methods of thermally conditioning hardware within a thermal vacuum environment. It is recommended that the reader be familiar with the basic principles of heat transfer to appreciate the full scope of the information presented. Included in the paper are practical measures taken using basic principles of heat transfer to manipulate the temperature of hardware tested in a vacuum chamber. This involves separate devices and controls working in agreement with instrumentation to achieve a desired thermal condition. Examples of test build ups and data results from actual tests will be included. Hazards and troubleshooting tips will also be discussed. All methods mentioned in this paper are those used by NASA at the Johnson Space Center, Crew and Thermal Systems Division, Systems Test Branch. This paper only makes reference to methods and techniques typically used in thermal and thermal vacuum testing at JSC facilities and in no manner make any effort to replace any current established regulations or guidelines.

TFAWS2012-IN-04

DAWN THERMAL CHALLENGES WHILE OPERATING AT VESTA

Juan Cepeda-Rizo, Jet Propulsion Laboratory, California Institute of Technology

ABSTRACT

The Dawn Spacecraft launched in the summer of 2007 and arrived to the first of two destinations, Vesta, in May of 2011 with a planned departure to Ceres in April 2012. Many years of planning dating well before the launch date culminated with the orbit injection into a survey orbit around Vesta this last summer. This presentation will give a thermal overview of the spacecraft, including its unique Ion Propulsion System (IPS). We will also discuss some of the daunting thermal challenges while operating around Vesta, which is a protoplanet 330 km in diameter, located 2.4 AU from the Sun in the main asteroid belt between Mars and Jupiter.

TFAWS2012-IN-05

OPALS MISSION THERMAL DESIGN STUDY

Daniel Zayas, Jet Propulsion Laboratory, California Institute of Technology

ABSTRACT

Conventional spacecraft thermal control systems rely heavily on strong conductive coupling to a radiator; such an approach fails, however, in cases where the hardware in question is incompatible with conductive cooling or where prolonged loss of power would result in dangerously low temperatures. A novel approach for convective thermal control of commercial-off-the-shelf (COTS) electronics in space is presented, wherein a laboratory thermal environment is replicated through the use of a sealed enclosure and gaseous cooling loops. This enables the safe operation of cheaper, more readily available electronics that would otherwise be unsuitable for the space environment. The flight thermal control system for the proposed Optical PAyload for Lasercomm Science (OPALS) mission, an externally-mounted payload planned for installation and operation aboard the International Space Station (ISS), is presented as a case study. Relatively simple hand calculations are corroborated by extensive modeling efforts in computational fluid dynamics (CFD) code. A full-scale test of the system is described. Low-cost thermal control hardware is shown to provide a high degree of performance margin and reliability.

TFAWS2012-IN-06

THERMAL AND ALIGNMENT ANALYSIS OF THE INSTRUMENT-LEVEL ATLAS THERMAL VACUUM TEST

Heather Bradshaw, NASA Goddard Space Flight Center

ABSTRACT

This paper describes the thermal analysis and test design performed in preparation for the ATLAS thermal vacuum test. NASA's Advanced Topographic Laser Altimeter System (ATLAS) will be flown as the sole instrument aboard the Ice, Cloud, and land Elevation Satellite-2 (ICESat-2). It will be used to take measurements of topography and ice thickness for Arctic and Antarctic regions, providing crucial data used to predict future changes in worldwide sea levels. Due to the precise measurements ATLAS is taking, the laser altimeter has very tight pointing requirements, involving a close-loop beam steering mechanism to maintain alignment. Therefore, the instrument is very sensitive to temperature-induced thermal distortions. For this reason, it is necessary to perform a Structural, Thermal, Optical (STOP) analysis not only for flight, but also to ensure performance requirements can be operationally met during instrument-level thermal vacuum testing. This paper describes the thermal model created for the chamber setup, which was used to generate inputs for the environmental STOP analysis. This paper also presents the results of the STOP analysis, which indicate that the test predictions adequately replicate the thermal distortions predicted for flight. This is a new application of an existing process, as STOP analyses are generally performed to predict flight behavior only. Another novel aspect of this work is that it presents the opportunity to verify pointing results of a STOP model, which is not generally done. It is possible in this case, however, because the actual pointing will be measured using flight hardware during thermal vacuum testing and can be compared to STOP predictions.

TFAWS2012-IN-07

A SYSTEM ANALYSIS DEMONSTRATION USING CIELO

Mike Chainyk, Jet Propulsion Laboratory, California Institute of Technology
Gregory Moore, Jet Propulsion Laboratory, California Institute of Technology

ABSTRACT

Cielo is a software platform developed at the Jet Propulsion Laboratory that specifically addresses the difficulties encountered in analyzing and simulating controlled optical systems. In contrast to traditional STOP analysis, a single compute framework and model instruction set is used to compute all temperatures, displacements, optical metrics and control loop interactions. All confusion and approximation associated with multiple physics models and software packages, coordinate systems, temperature mapping, displacement extraction and projection, rigid body motions, optical metric recovery and control loop interactions is uniquely eliminated in this process. A brief review of the enabling technologies in Cielo will be provided in the context of the demonstration.

An interactive example problem of approximately 6K thermal and 25K structural DOF will be used to demonstrate the streamlined procedure, and selected results taken from recent Exoplanet mission concept studies will be used to demonstrate the scalability of the framework.