INTERDISCIPLINARY SESSION TOPICS

Interdisciplinary Session #1 (Wednesday 1:00PM to5:00PM)

ID	Title	Lead Author
TFAWS2012-IN-01	Computational Fluid Dynamics Tool Assessment – Comparison of CFDesign 2011 and STAR-CCM+ V6 using Test Case Suite	Bret J. Naylor, Ph.D.
TFAWS2012-IN-02	Computational Fluid Dynamics (CFD) Analysis of Optical Payload for Lasercomm Science (OPALS) Sealed Enclosure Module	Dr. Kevin R. Anderson
TFAWS2012-IN-03	Regeneratively Cooled Rocket Nozzle CFD Cooling System Analysis	Matt Devost
TFAWS2012-IN-04	Thermal Vacuum Testing: Methods of Thermal Conditioning in a Vacuum Environment	Michael McCullar
TFAWS2012-IN-05	Thermal and Alignment Analysis of the Instrument-Level ATLAS Thermal Vacuum Test	Heather Bradshaw
TFAWS2012-IN-06	Dawn Thermal Challenges While Operating at Vesta	Dr. Juan Cepeda-Rizo

TFAWS2012-IN-01

COMPUTATIONAL FLUID DYNAMICS TOOL ASSESSMENT – COMPARISON OF CFDESIGN 2011 AND STAR-CCM+ V6 USING TEST CASE SUITE

Bret J. Naylor, Ph.D., Jet Propulsion Laboratory, California Institute of Technology

ABSTRACT

As part of an internal review of computational fluid dynamics software packages, several test cases of restricted fluid flow and heat transfer were developed and analyzed using CFdesign 2011 from Blue Ridge Numerics, Inc. and STAR-CCM+ V6 from CD-adapco. The simple test cases described in this paper can be simulated quickly in modern computer hardware and are useful for both novice user training and tool evaluation. The simulation results from both packages are compared for numerical agreement and graphical presentation of simulation data. Agreement between the two evaluated packages is generally quite good however some localized discrepancies are found. One of the test cases, two-dimensional flow between parallel plates, has an arithmetic solution to which the simulation results are compared. While both packages produced results within 10% of the analytical solution, STAR-CCM+'s results were much more accurate and improved as the mesh density was increased. The convergence time for the test cases is analyzed to provide a very-coarse estimate of the computation time required for CFD analysis based on simulation volume, expected feature size and meshing primitive. Based on this simulation-time estimator, STAR-CCM+ is 6 to 12 times faster than CFdesign on a modern multi-core, single-processor desktop computer. Based on the results of this tool assessment and that of others, JPL has adopted STAR-CCM+ for CFD analysis in fiscal year 2012 and will continue to evaluate the utility and appropriateness of this package in the coming years.

TFAWS2012-IN-02

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

Placeholder for abstract (it is written but waiting on export control approval).

TFAWS2012-IN-03

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-04

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-05

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-06

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.