



### ⚙️ **Dedicated Deployable Aerobraking Structure**

A dedicated deployable aerobraking structure concept was developed that significantly increases the effective area of a spacecraft during aerobraking by up to a factor of 5 or more (depending on spacecraft size) without substantially increasing total spacecraft mass. Increasing the effective aerobraking area of a spacecraft (without significantly increasing spacecraft mass) results in a corresponding reduction in the time required for aerobraking. For example, if the effective area of a spacecraft is doubled, the time required for aerobraking is roughly reduced to half the previous value. The dedicated deployable aerobraking structure thus enables significantly shorter aerobraking phases, which results in reduced mission cost, risk, and allows science operations to begin earlier in the mission.

In order to achieve a large area without impacting the spacecraft or launch vehicle, a deployable structure is necessary. The dedicated deployable aerobraking structure uses a set of deployable rigid "arms" to deploy and support a large membrane. The membrane is made of material (Kapton, for example) that can withstand the thermal and mechanical loads characteristic of aerobraking. Once aerobraking is complete, this aerobraking structure would be jettisoned into an atmosphere-intercepting orbit and subsequently destroyed upon atmospheric entry. This concept uses a mechanical implementation distinct from inflatable aerodynamic decelerators studied for aerocapture and other applications. Aerobraking requires multiple passes through the atmosphere over several weeks (at least), and so any small leaks or punctures that develop in an inflatable structure during that time could compromise the inflatable structure; this makes inflatable structures a higher risk implementation for an aerobraking structure relative to the mechanical implementation used in this concept.

Tentative mechanical and thermal requirements for this technology have been developed. Full-scale proof of concept hardware corresponding to one quadrant of a 72 m<sup>2</sup> aerobraking structure was successfully designed, fabricated, deployed, and tested. The lab

tests were designed so that the mechanical loads in the 1-g lab environment were higher than the anticipated aerobraking loads, which proved the structure could survive in flight. Finite element models were developed and found to be in good agreement with the proof-of-concept hardware. Thermal and attitude stability aspects of the concept were analyzed. Based on the preliminary requirements, hardware tests, computational models, and analyses developed, the concept was found to be viable using conventional engineering materials and techniques.

In addition to potential use on planetary missions, this technology can also be used as an inexpensive, robust, and reliable method for reducing orbital debris hazards in Earth orbit by increasing the rate of orbital decay of objects in orbit about the Earth such as decommissioned satellites and spent launch vehicle upper stages.

*This work was done by Louis R. Giersch and Kevin Knarr of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-47227*

### 🔍 **Portable Health Algorithms Test System**

A document discusses the Portable Health Algorithms Test (PHALT) System, which has been designed as a means for evolving the maturity and credibility of algorithms developed to assess the health of aerospace systems. Comprising an integrated hardware-software environment, the PHALT system allows systems health management algorithms to be developed in a graphical programming environment, to be tested and refined using system simulation or test data playback, and to be evaluated in a real-time hardware-in-the-loop mode with a live test article.

The integrated hardware and software development environment provides a seamless transition from algorithm development to real-time implementation. The portability of the hardware makes it quick and easy to transport between test facilities. This hardware/software architecture is flexible enough to support a variety of diagnostic applications and test hardware, and the GUI-based rapid prototyping capability is sufficient to support devel-

opment, execution, and testing of custom diagnostic algorithms.

The PHALT operating system supports execution of diagnostic algorithms under real-time constraints. PHALT can perform real-time capture and playback of test rig data with the ability to augment/modify the data stream (e.g. inject simulated faults). It performs algorithm testing using a variety of data input sources, including real-time data acquisition, test data playback, and system simulations, and also provides system feedback to evaluate closed-loop diagnostic response and mitigation control.

*This work was done by Kevin J. Melcher and Edmond Wong of Glenn Research Center and Christopher E. Fulton, Thomas S. Sowers, and William A. Maul of Analex Corp. Further information is contained in a TSP (see page 1).*

*Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steve Fedor, Mail Stop 4-8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18485-1.*

### 🔍 **Technique for Performing Dielectric Property Measurements at Microwave Frequencies**

A paper discusses the need to perform accurate dielectric property measurements on larger sized samples, particularly liquids at microwave frequencies. These types of measurements cannot be obtained using conventional cavity perturbation methods, particularly for liquids or powdered or granulated solids that require a surrounding container. To solve this problem, a model has been developed for the resonant frequency and quality factor of a cylindrical microwave cavity containing concentric cylindrical samples. This model can then be inverted to obtain the real and imaginary dielectric constants of the material of interest.

This approach is based on using exact solutions to Maxwell's equations for the resonant properties of a cylindrical microwave cavity and also using the effective electrical conductivity of the cavity walls that is estimated from the measured empty cavity quality factor. This new approach calculates the complex resonant frequency and associated electromagnetic fields for a cylindrical mi-