

## LDR Structural Technology Activities at JPL

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This paper summarizes the status of the LDR technology requirements and the availability of that technology in the next few years. The research efforts at JPL related to these technology needs are also discussed. LDR requires that a large (20 meters in diameter) and relatively stiff (frequencies  $\geq 5$ -10 Hz) truss-type backup structure have a surface accurate to  $100 \mu\text{m}$  in space (initial position with thermal distortions) and the dynamic characteristics predictable and/or measurable by on-orbit system identification for micron level motion. This motion may result from the excitation of the lower modes or from wave-type motions. It is also assumed that the LDR structure can be ground tested to validate its ability to meet mission requirements. No program manager will commit a structural design based solely on analysis, unless the analysis is backed by a validation test program.

Technology development is required for new ground test approaches to validate the LDR structure; the current state of the art is not adequate because of the adverse effects of the terrestrial environment. Ground test approaches under investigation at JPL, which would allow testing of structures, include multi-boundary-condition tests (MBCT), initial position determination, and proper identification of interface effects. Almost no efforts exist in trying to experimentally evaluate the micron level static and dynamic characteristics truss-type structures dominated by joints.

Technology is required to analytically characterize the micron level and wave motion behavior of structures. Based on experience to date, current state of the art analytical approaches are inadequate. A combined analytical/experimental program is required to develop acceptable models.

Current system identification methods are unable to identify the characteristics of a structure; the situation is compounded when identification of micron-level and wave-type characteristics are required.

Concepts of adaptive or active structures are under development at JPL, and will lead to solutions of the many technology challenges for LDR. Adaptive structures allow the adjustment of a structure in space at the micron level and/or at large displacement levels. Active elements within the truss system can detect nanometer level relative displacements and apply the forces necessary to provide damping, isolation, submicron positioning. Active structures thus alleviate some of the ground test requirements because the structure can be adjusted in space to meet the in-space requirements. Since active members can detect small motions, they can be directly used to sense and add damping to micron level modal and/or wave-type

motions. They can also be used to excite and then sense the displacements and forces for on-orbit system identification. Since active elements only impart equal and opposite forces into the structure, they cannot impart rigid body motions into the structure. The objective is to place local controls at the active elements, and to decouple them from the system used to provide rigid body control for the spacecraft. The local controls would be invisible to this central control system and have a benign effect on it.