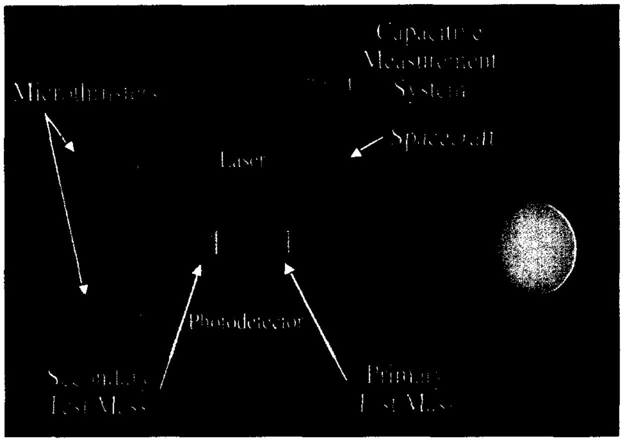
Disturbance Reduction System New Millennium Program Space Technology 7	For further information contact William.Folkner@jpl.nasa.gov



Concept Definition Description

The Disturbance Reduction System (DRS) will validate system-level technologies required for use on so-called "drag-free" spacecraft, i.e., spacecraft that are controlled to follow a trajectory determined only by external gravitational forces (a geodesic). Other forces, such as atmospheric drag or solar radiation pressure, that would disturb the trajectory are eliminated by the DRS. The DRS will control the spacecraft position to follow a geodesic within a fraction of a wavelength of light. The key new technologies are gravitational reference sensors and microthrusters.

A gravitational reference sensor consists of a freely-floating test mass within a housing, along with a measurement system for determining the position of the test mass with respect to the housing. The housing is attached to a spacecraft which shields the test mass from nongravitational forces. To prevent solar pressure from pushing the spacecraft into contact with the test mass, the spacecraft position is measured with respect to the test mass. As the solar pressure forces the spacecraft towards the test mass, the position change is sensed and microthrusters are used to adjust the position of the spacecraft back to the desired position. The spacecraft essentially flies in formation with the test mass. The first use of this type of spacecraft position control was in Earth orbit, where the primary nongravitational force was atmospheric drag, leading to the term "drag-free" control.

In order to avoid interactions between the spacecraft and the test mass, it is necessary to control their relative position so that variations are smaller than a wavelength of light. This requires thrusters capable of extremely fine precision. The DRS will use a new type of thrusters, frequently referred to as colloid thrusters, which eject charged droplets with velocities precisely adjusted by an accelerating voltage, for the required control.

In order to validate that the test mass is following a geodesic, its trajectory must be compared with that of a reference object. For DRS, the reference will be a second test mass also within the spacecraft. The distance between the two test masses will be measured with a laser interferometer to verify that the two test masses follow the same trajectory.

Applicability

The two classes of future space missions that will benefit from DRS technologies are gravity missions and separated-spacecraft interferometer missions. The DRS technology is mission enabling for the planned Laser Interferometer Space Antenna (LISA) gravitational-wave observatory, and is also in the baseline plan for a future mission for mapping the Earth's variable gravity field. X-ray or gamma-ray separated-spacecraft interferometers, such as the MicroArcsecond X-ray Imaging Mission (MAXIM), require spacecraft position control at levels the DRS will validate. For optical and infrared separated-spacecraft interferometry missions, such as the Terrestrial Planet Finder (TPF), DRS technology will provide alternative approaches to position control which may enhance mission performance or lower mission cost.

Implementation

The DRS project will be implemented by a team of scientists and engineers from JPL, Stanford University, Busek Co. Inc, and the Goddard Space Flight Center in partnership with the European Space Agency. Stanford University will develop the gravitational reference sensors, Busek Co. Inc will develop the colloid thrusters; GSFC will develop the spacecraft control software, and JPL will develop the interferometer and manage the overall project.

The DRS instrument package and microthrusters will be flown on the European Space Agency's SMART-2 spacecraft which will be launched in mid-2006. The DRS total project cost is $62.6 M.