NASA Electronic Parts and Packaging Program(NEPP)

Title: **X** New Proposal

Total $ Requested for FY01: $300K

Technology Type: **X** Emerging/Advanced

Project Area: **X** Packaging

Proposing Centers: Center A

Participating Centers: 100% JPL

Collaborators:

The task involves collaboration between a number of interdisciplinary partners. Several industry participants have been identified through the former PASS (Photonic Applications for Small Spacecraft) effort. Companies which have expressed interest in participating are Lockheed-Martin, TRW, Lightwave, Swales,and Rifocs.
We are soliciting participation from CalTech faculty and Grad students.

Points of Contact:

Robert Graber, David Mih, William Klipstein, Tien-Hsin Chao, and Siamak Forouhar.

Investigators: Robert Graber/David Mih

Objectives:

Identify and validate the components, materials, and processses required to produce flight qualified optical assemblies. These optical assemblies will be designed to perform with the stability and reliability levels required to satisfy long duration metrology and spectrometry missions on small satellites.

Task Description:

The Jet Propulsion Laboratory has recently developed and demonstrated leading edge technology in several areas related to high performance photonic/optical circuitry including laser cooled atomic clocks, high capacity optical communication busses, high density/high transfer rate holographic memory modules, and metrological interferometers. The technology has so far been demonstrated at the laboratory investigation scale only. We wish to validate the methodology by which these instruments can be reduced in mass and size, in order to be considered for flight missions in the first decade of the next century.

Task Approach:

1) Validation vehicles will be fabricated to demonstrate several key technologies which are very desirable for future science missions. These technologies all relate to optical assembly structures (where an optical assembly may consist of a mounting platform or package, a laser source, and the assorted components such as isolators, modulators, lenses, and magnets required to maintain high output efficiency) Technologies include optical bus, holographic memory modules, laser radar, laser cooled atomic clocks, and interferometers.
2) Completed demonstration vehicles will be measured for baseline performance levels as defined by the cognizant mission scientists.
3) Validation vehicles will then be subjected to the accelerated environments test screens which emulate conditions for both terrestrial and deep space missions for spectrometry and metrology.
4) Demonstrator vehicle performance will be remeasured after screening tests to validate reliability of design.
5) The test vehicles will then be operated over an extended time frame to demonstrate long term stability.
6) Progress of the validation vehicles as they proceed through testing will be documented and disseminated through internal NASA channels such as EEE Links or NASA Tech Briefs.
7) At the conclusion of this effort, a results summary report and user guidelines will be published.

Technical Backround:

The techniques and processes currently being used to repackage the Laser Cooled Atomic Clock are also applicable for other optical packaging efforts. Knowledge gained on this effort will be leveraged so that packaging for Laser Radar, Interferometers, and Holographic Memory will also be capable of satisfying critical performance requirements for NASA's New Millenium Series of Micro/Nano Spacecraft.

Technical Approach:

Evaluation and validation tasks will be performed in incremental steps. This will allow participating team members to address cross-enterprise interests and to assess whether validation has been truly accomplished to the level required for flight missions.
The approach for the holographic memory module (Compact Holographic Data Storage—CHDS) will be as follows:

- Repackage the CHDS breadboard, which is currently running on a laboratory optical table, approximately 4' x 4', which will consist of a diode laser, a photorefractive $LiNbO_3$ storage crystal, a spatial light modulator, and a CCD detector. Validate alignment and micropositioning methods.

- Perform reliability validation test series for the packaged CHDS for sensitivity to temperature cycling, vibration, and jitter.

- Improve the packaging architechture and upgrade the system performance based on validation test results.

The CHDS is a very small, 5mm x 5mm x 5mm, crystal of lithium niobate which functions as an optical memory storage device. Data is stored and retrieved as holograms at extremely high transfer rates(1-10Gb/sec). The capacity of a single crystal may be as much as 1 Terabyte. The data is stored and retrieved with no moving parts. If this type memory can be packaged and validated for future flight missions, the amount of science data which can be gathered will improve by several orders of magnitude over that currently being included on missions launched in 1999.

This method of evaluation, validation, and feedback through iteration is currently being applied to the packaging of the laser cooled atomic clock. The current laboratory clock is laid out on an 8' x 4' optical table. The current packing effort aims to reduce both mass and volume of the atomic clock by 100x while retaining or improving upon the present stability parameters. These same iterative techniques will be applied to laser radar and the metrology interferometers.

NASA Customers: SIM, ST-3, future Metrology/Interferometer missions, PARCS, RACE, 632 Holographic Memory, ET Laser Radar for Mars '05 Rendezvous and Return

Deliverables:

- 1st Quarter (Oct.'00-Dec'00)--Components selection. COTS, COTS repackaged, Custom.
- 2nd Quarter (Jan'01-Mar'01)—Test and validate repackaged demonstrator vehicles

- 3rd Quarter (Apr'01-Jun'01)—632 Holographic Memory Demonstrator Validation

- 4th Quarter(Jul'01-Sept'01)—ET Laser Radar Optical Packaging Validation

Top Level Schedule:

See attachment.

List of Procurements:

None

Leveraging:

Several future JPL missions must use optical components and/or techniques to realize their desired science objectives. The ability to package the optical systems in a manner such that they are reliable, yet small enough to fly, has yet to be documented. This effort will be directed toward optical packaging validations and solutions which will be applicable for the interests of a number of missions. In addition, the results will be shared with all industrial collaborators, as appropriate. They, in turn, will be contributing to our efforts in like fashion. Most of these partners have also made significant investments of both manpower and funding as applied to packaging compact optical systems for space flight missions.