other number of atoms in the initial m_F = 0 level.

Unlike the m_F = 0 level, the m_F = +1 and m_F = –1 levels are sensitive to an applied magnetic field. Therefore, several milliseconds before turning off the optical trap, a suitably oriented magnetic field having a gradient is turned on. By virtue of their different sensitivities to the magnetic field, atoms in the m_F = +1 level can be coupled out of the trap region in one direction and atoms in the m_F = –1 level in a different direction (see figure), thereby generating the desired two pulsed beams containing equal numbers of atoms. (The m_F = 0 atoms are affected only by the same gravitational force that affects the m_F = +1 and m_F = –1 atoms.)

This work was done by Robert Thompson, Nathan Lundblad, Lute Maleki, and David Aveline of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).
NPO-43741

Rugged, Tunable Extended-Cavity Diode Laser

This laser is relatively insensitive to vibration.

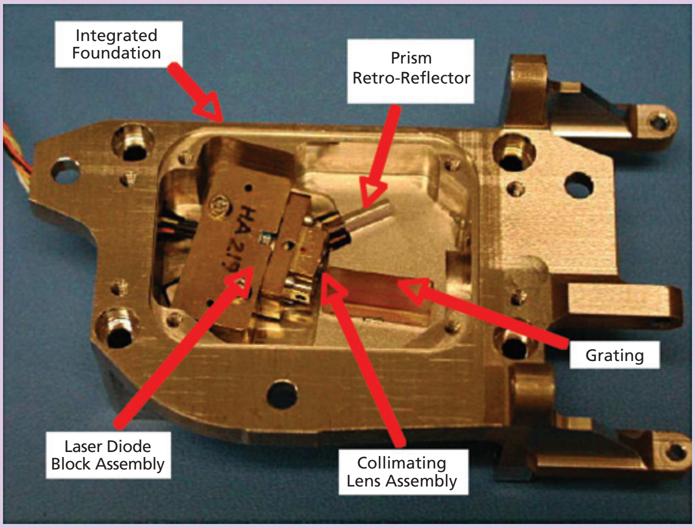
NASA's Jet Propulsion Laboratory, Pasadena, California

A rugged, tunable extended-cavity diode laser (ECDL) has been developed to satisfy stringent requirements for frequency stability, notably including low sensitivity to vibration. This laser is designed specifically for use in an atomic-clock experiment to be performed aboard the International Space Station (ISS). Lasers of similar design would be suitable for use in terrestrial laboratories engaged in atomic-clock and atomic-physics research.

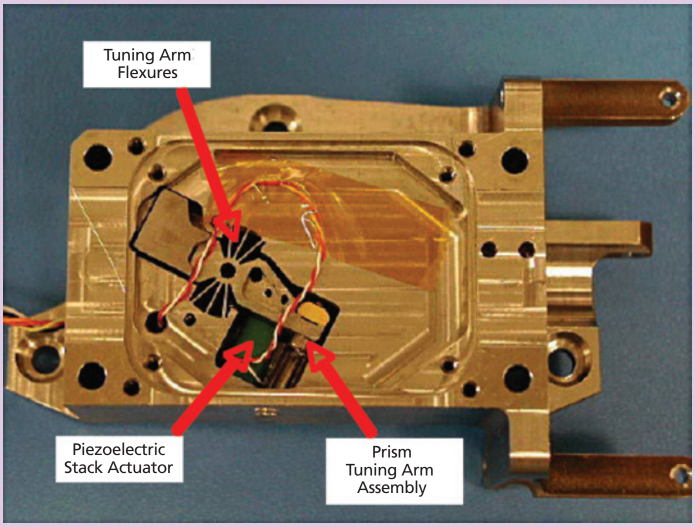
Prior ECDLs, including commercially available ones that were considered for use in the original ISS application, were found to exhibit unacceptably high frequency noise in vibration tests. The high vibration sensitivity of those lasers was attributed to relatively low stiffness of tuning-arm mechanisms, characterized by fundamental-mode vibrational resonance frequencies of ≈2 kHz. In the design of the present ECDL, sensitivity to vibration is increased by increasing stiffness to a point characterized by a fundamental-mode vibrational resonance frequency >6 kHz.

The laser (see figure) includes a laser diode, an optical isolator at the laser output aperture, a collimating-lens assembly, a fixed grating, and a retroreflector prism on a pivoting tuning arm that is driven by a piezoelectric-stack actuator. The tuning arm pivots on flexure blades. The tuning arm and flexure blades are integral to an optical foundation made of Invar (a low-thermal-expansion iron-nickel alloy) and were formed by wire electrical-discharge machining of the foundation. The piezoelectric actuator is held in compressive preload by the flexure blades.

All of the aforementioned components except the flexure blades, tuning arm, and retroreflector are aligned and rigidly mounted within the Invar optical



TOP VIEW



BOTTOM VIEW

In this **Tunable Extended-Cavity Diode Laser**, tuning is effected by piezoelectric actuation of the tuning arm, which pivots on the flexure blades.

foundation. The laser diode is bonded into a mounting block in such a manner that there is thermal conduction but electrical isolation between the laser-diode case and the optical foundation. The collimating lens is carefully aligned and bonded into the mounting block. The retroreflector prism is bonded to the tuning arm. The tuning arm, the flexures, and the stroke of the piezoelectric actuator were designed to obtain a laser frequency tuning range >125 GHz as well as the vibrational resonance frequency in excess of 6 kHz, while maintaining a minimum compressive load of 1,000 psi (≈6.9 MPa) on the actuator.

This work was done by Donald Moore, David Brinza, David Seidel, and William Klipstein of Caltech and Dong Ho Choi, Lam Le, Guangzhi Zhang, Roberto Iniguez, and Wade Tang of New Focus/Bookham Technology for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

Innovative Technology Assets Management
JPL
Mail Stop 202-233
4800 Oak Grove Drive
Pasadena, CA 91109-8099
(818) 354-2240
E-mail: iaoffice@jpl.nasa.gov

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