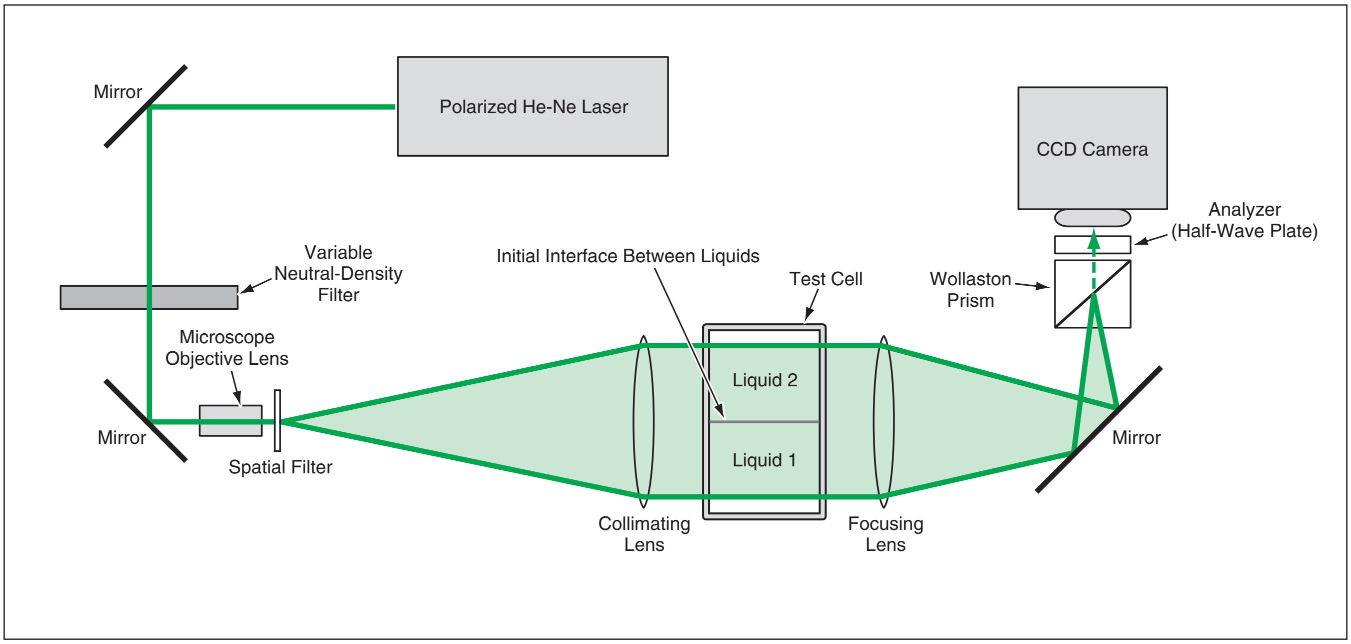


A **Common-Path Interferometer** projects a polarized, collimated horizontal light beam through a test cell that contains two pure liquids and a mixing layer between them.

refraction is horizontally uniform and varies only as a function of height above or below the initial interfacial plane.

An important element of the present method is rotation of the Wollaston prism around its optical axis by a small amount chosen so that the interference fringes form at a slight angle with respect to the initial interface between the liquids. The advantage of this angle is not intuitively obvious, and can be understood only in terms of the applicable equations. In summary, what the equations show is that proper choice of the angle results in magnification of the visual effect of the gradient of concentration in the mixing zone. Without the proper choice of the angle, the interference-fringe image cannot be interpreted simply or used to obtain the diffusivity of the fluids.

This work was done by Nasser Rashidnia of **Glenn Research Center**. *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, Commercial Technology Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-17375.

Zero-Shear, Low-Disturbance Optical Delay Line

The only optical components would be two flat mirrors.

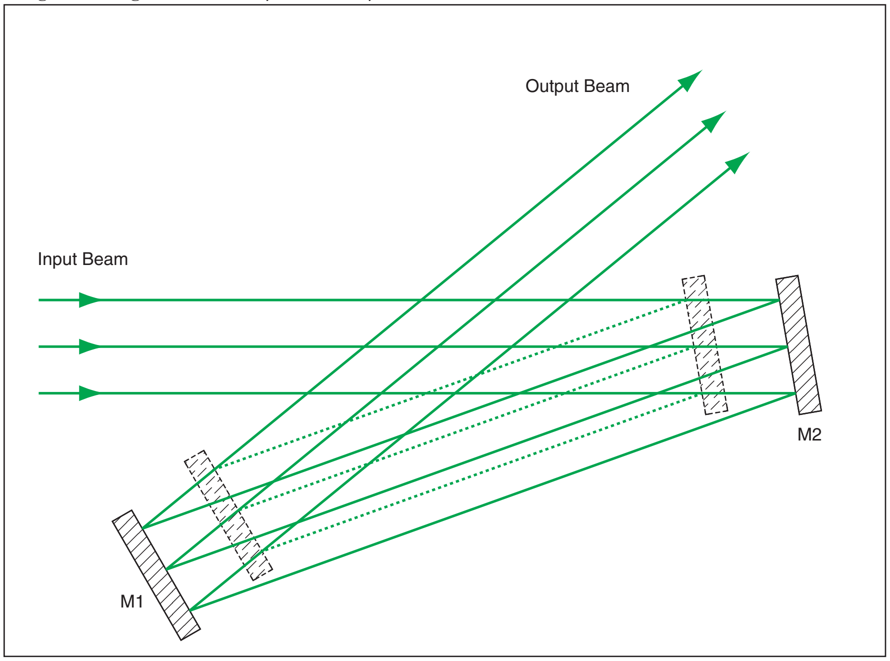
NASA's Jet Propulsion Laboratory, Pasadena, California

A design concept has been proposed for an optomechanical apparatus that would implement a variable optical delay line with a fixed angle between its input and output light beams. The apparatus would satisfy requirements that emphasize performance in interferometric applications: to contain a minimum number of optical surfaces, each used at low angle-of-incidence, and to be nominally free of shear (transverse motion of the beam) on any optical element. As an additional advantage, the apparatus would afford partial compensation of vibration disturbances associated with adjustment of the optical delay by both reducing the amount of motion required to achieve a desired optical delay and by splitting the total motion between two assemblies. As compared to prior art implementations of delay lines, the only disadvantage of the concept is that the motions of the optical elements must be well coordinated through mechanical linkages or electronic controls.

The figure depicts a typical configuration of the apparatus. The optical elements would be two flat mirrors — M1 and M2 — mounted on linear actuators. The actuation axes of M1 and M2 would be parallel to the incoming and outgoing light beams, respectively. M1 would be mounted on its actuator at a fixed angle required to aim the beam reflected from it to the center of M2. In turn, M2 would be mounted on its actuator at a fixed angle required to aim the outgoing beam in the desired direction. Moreover, the angles of M1 and M2 would be chosen so that the angle between M1 and the incoming beam equals the angle between M2 and the outgoing beam.

All of the properties of this apparatus that make it preferable to prior variable optical delay lines depend on making M1 and M2 move by equal and opposite amounts to vary the length of the optical path: In shortening (or lengthening) the optical path, one must move M1 a required distance along the input beam path toward (or away from) M2 while moving M2 along the same distance along the output-beam path toward (or away from) M1. It is noted that the path length change introduced by the linear motion of each mirror is greater than just the distance actually traversed by the mirror. In most configurations, the path length change effected by the delay line is more than 3 times the actual distance moved by either mirror.

As a result of this geometric arrangement and coordination of motions, the incoming beam would always strike M1 at the same point, the beam reflected from M1 would always strike M2 at the same point, and the outgoing beam would always strike the next optical element in the output path at the same point, giving zero beam shear at all times. Assuming that the mirrors and their associated mounts would have equal masses, the vector component of the motions of the mirrors along the line joining the centers of the mirrors would introduce no net momentum disturbance, and thereby no significant vibrational perturbations into the surrounding structure. There would remain a small, uncompensated vector component of momentum disturbance along the direction perpendicular to the line between the centers of the mirrors; optionally, one could compensate for this component of momentum disturbance by use of a relatively small auxiliary moving mass.



Coordinated Motion of Mirror M1 and Mirror M2 along the input and output axis, respectively, would ensure that the light beam remained centered on both M1 and M2 at all times.

This work was done by Jeffrey Oseas of Caltech for **NASA's Jet Propulsion Laboratory**. *Further information is contained in a TSP* *(see page 1)*.

NPO-30820

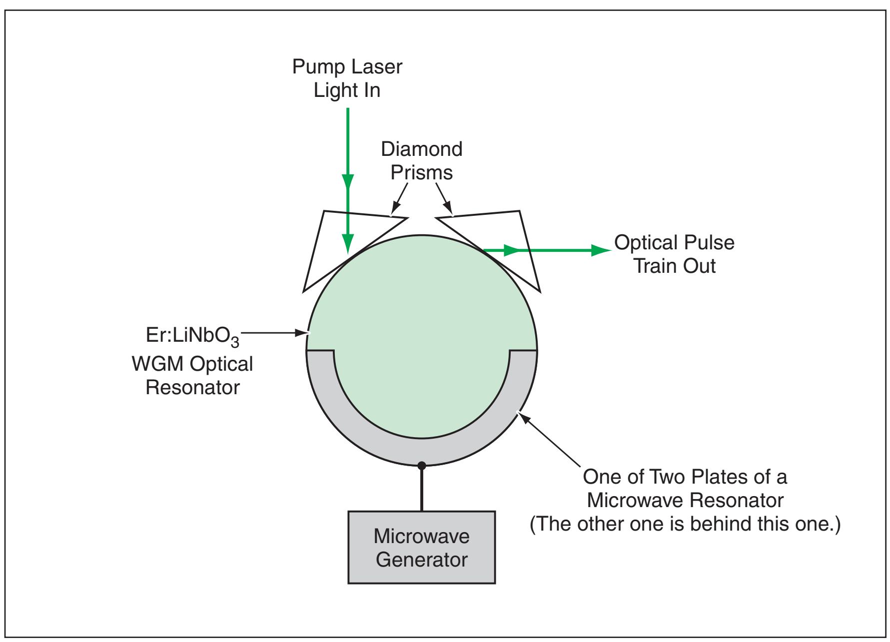
Whispering-Gallery Mode-Locked Lasers

Compact devices would generate optical pulses at repetition rates of tens of gigahertz.

NASA's Jet Propulsion Laboratory, Pasadena, California

Mode-locked lasers of a proposed type would incorporate features of the design and operation of previously demonstrated miniature electro-optical modulators and erbium-doped glass lasers that contain whispering-gallery-mode (WGM) resonators. That is to say, WGM lasers and WGM electro-optical modulators would be integrated into monolithic units that, when suitably excited with pump light and microwaves, would function as mode-locked lasers. The proposed devices are intended to satisfy an anticipated demand for compact, low-power devices that could operate in the optical-communication wavelength band centered at a wavelength of 1.55 μm and could generate pulses as short as picoseconds at repetition rates of multiple gigahertz.

A representative device according to the proposal (see figure) would include a WGM optical resonator in the form of an oblate spheroid or disk that would have a diameter of the order of a millimeter and would be made from z-cut lithium nio-



A **Whispering-Gallery Mode-Locked Laser** would include a WGM optical resonator made of an optically nonlinear material placed between plates of a microwave resonator so that the microwave and optical resonators would also function as an electro-optical modulator that would couple the microwave and optical fields.