

This Fourier X-Ray/ $\gamma$ -Ray Telescope would contain only one pair of parallel absorbing/scattering grids, whereas prior such telescopes contain greater numbers of such grids.

*priori*, it would be convenient to align the middle element of the detector with the central slits of the inner and outer grids. With this alignment, a point source on the axis of symmetry of the telescope would produce a fringe pattern having peak intensity on the middle detector element. As the point source moved off the axis, the fringe pattern would shift accordingly, enabling acquisition of data on the amplitude and phase of the spatial-frequency component corresponding to the slit width, distance between the grids, and grid angle. The processor would sum the photon counts on the detector elements to produce a four-parameter output data stream indicative of the intensity and location of the peak amplitude on the detector (equivalently, of magnitude and phase) as functions of the angle of rotation and the distance between the grids.

*This work was done by Jonathan Campbell of Marshall Space Flight Center.*

*This invention is owned by NASA, and a patent application has been filed. For further information, contact Sammy Nabors, MSFC Commercialization Assistance Lead, at [sammy.a.nabors@nasa.gov](mailto:sammy.a.nabors@nasa.gov). Refer to MFS-31805-1.*

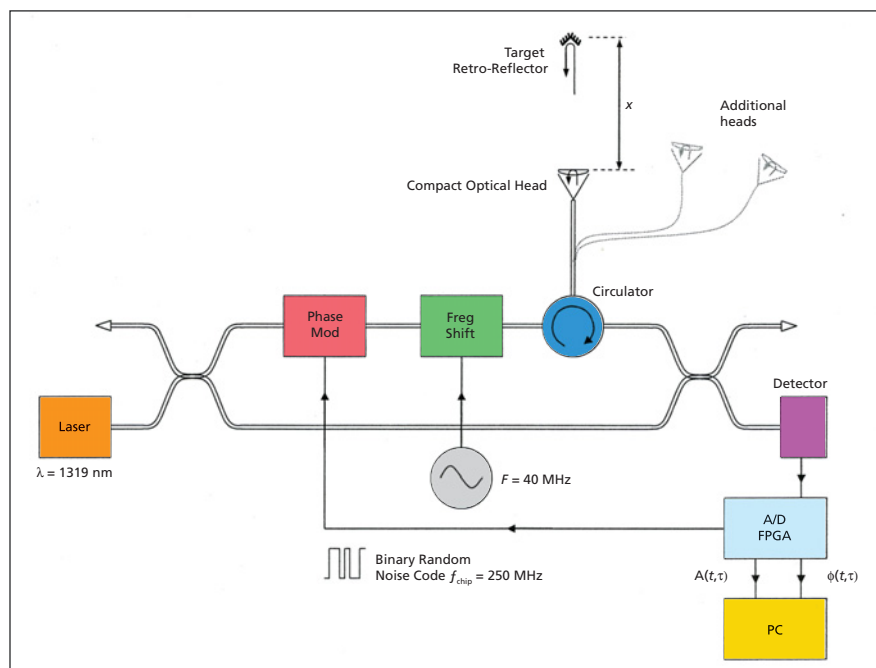
## Range-Gated Metrology With Compact Optical Head

**A compact, single-fiber optical head requires minimal internal alignment.**

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This work represents a radical simplification in the design of the optical head needed for high-precision laser ranging applications. The optical head is now a single fiber-optic collimator with dimensions of order of  $1 \times 2$  cm, which can be easily integrated into the system being measured with minimal footprint. Previous heads were significantly larger, with multiple optical elements requiring careful alignment. The new design has only one optical fiber per head, rather than four, making it much easier to multiplex between tens or hundreds of heads. It is capable of subnanometer precision, consistent with the demanding requirements of new missions.

By combining a large number of multiplexed, low-cost, ultra-compact optical heads, it will be possible to form dense optical trusses, with minimal footprint, for the stabilization of large precision structures. The compact heads could be integrated with a piezoelectric actuator inside a tube to provide an "active strut"



A schematic of the Range-Gated Metrology System.

— a lightweight, structural member with infinite stiffness and zero thermal expansion — which can form the basis for extremely stable, lightweight structures. The compact heads could also be used as a tool in the laboratory for monitoring vibration and drifts in the dimensions of an experiment. Laser metrology may thus attain the same level of utility as accelerometers and thermistors. Simple magnetic or snap-on mounts could be used to position and point the heads and target retro-reflectors.

This advance in optical-head design is enabled by the application of pseudo-random noise (PRN) codes to optical metrology systems. This code is used to

discriminate between multiple optical returns that have different propagation delays. In this way, the phase of the signal from the reference surface on the optical head can be measured independently of the phase of the signal from the more distant target retro-reflector.

A prototype system has been assembled in the laboratory. The data were recorded on a digital oscilloscope, and the signal processing was applied off-line in software. Future work will include the implementation of the software algorithms in a real-time FPGA-based signal processing system, and the demonstration of different multiplexing schemes.

*This work was done by Serge Dubovitsky,*

*Daniel Shaddock, Brent Ware, and Oliver Lay of Caltech 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:*

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