



## Submillimeter Confocal Imaging Active Module

This system could be used to image shorter objects between taller ones.

NASA's Jet Propulsion Laboratory, Pasadena, California

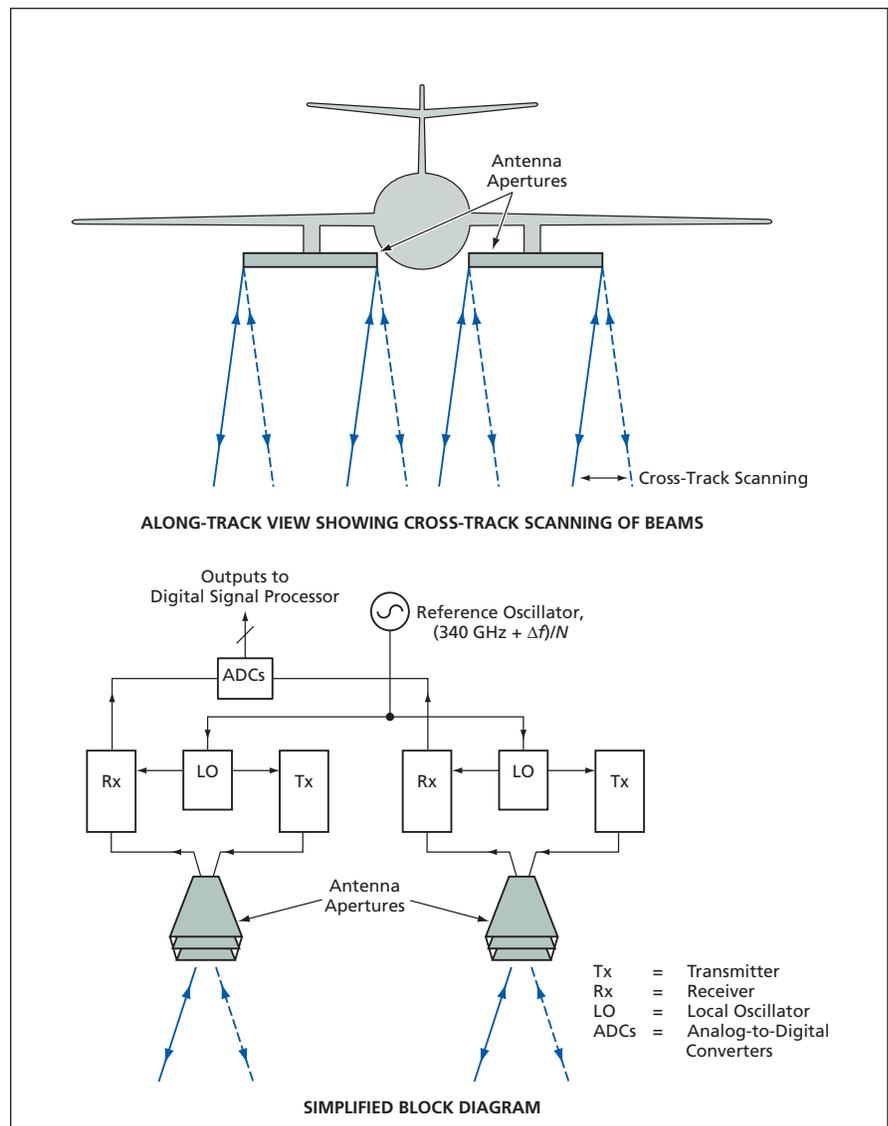
The term "submillimeter confocal imaging active module" (SCIAM) denotes a proposed airborne coherent imaging radar system that would be suitable for use in reconnaissance, surveillance, and navigation. The development of the SCIAM would include utilization and extension of recent achievements in monolithic microwave integrated circuits capable of operating at frequencies up to and beyond a nominal radio frequency of 340 GHz. Because the SCIAM would be primarily down-looking (in contradistinction to primarily side-looking), it could be useful for imaging shorter objects located between taller ones (for example, objects on streets between buildings). The SCIAM would utilize a confocal geometry to obtain high cross-track resolution, and would be amenable to synthetic-aperture processing of its output to obtain high along-track resolution.

The SCIAM (see figure) would include multiple (two in the initial version) antenna apertures, separated from each other by a cross-track baseline of suitable length (e.g., 1.6 m). These apertures would both transmit the illuminating radar pulses and receive the returns. A common reference oscillator would generate a signal at a controllable frequency of  $(340 \text{ GHz} + \Delta f)/N$ , where  $\Delta f$  is an instantaneous swept frequency difference and  $N$  is an integer. The output of this oscillator would be fed to a frequency-multiplier-and-power-amplifier module to obtain a signal, at  $340 \text{ GHz} + \Delta f$ , that would serve as both the carrier signal for generating the transmitted pulses and a local-oscillator (LO) signal for a receiver associated with each antenna aperture.

Because duplexers in the form of circulators or transmit/receive (T/R) switches would be lossy and extremely difficult to implement, the antenna apertures would be designed according to a spatial-duplexing scheme, in which signals would be coupled in and out via separate, adjacent transmitting and receiving feed horns. This scheme would cause the transmitted and re-

ceived beams to be aimed in slightly different directions, and, hence, to not overlap fully on the targets on the ground. However, a preliminary analysis has shown that the loss of overlap would be small enough that the resulting loss in signal-to-noise ratio (SNR) would be much less than the SNR loss associated with the use of a 340-GHz T/R switch.

In each antenna aperture, the receiving and transmitting feed horns would face a reflector structure that would be designed partly according to both a Fresnel-lens principle to minimize antenna volume and partly according to a diffraction-grating principle so that the beam direction in the cross-track plane would become dependent on the signal frequency. The Fresnel surfaces would



The SCIAM would initially include two antenna apertures, through each of which radar signals would be both transmitted and received. The antenna structures in each aperture would be frequency-dispersive so that frequency scanning could be used to effect cross-track scanning.

be confocal paraboloids having focal-length increments of a half wavelength, and the sizes of the Fresnel steps would be chosen to obtain a desired amount of angular deviation for a given amount of frequency tuning. For example, according to one tentative design, sweeping the radio frequency from 335 to 345 GHz would cause the beam to scan a cross-track ground swath 30 m wide

from a height of 1 km. Through post-detection processing of the return signals received via the two apertures, a cross-track image resolution of 27 cm would be obtained; in effect, the 30-m cross-track swath could be divided into 111 pixels of 27-cm width. Comparable along-track resolution would be obtained through synthetic-aperture post-processing.

*This work was done by John Hong, Imran Mehdi, Peter Siegel, Goutam Chattopadhyay, and Thomas Cwik of Caltech; Mark Rowell of the University of California, Santa Barbara; and John Hacker of Rockwell Scientific Company LLC for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).  
NPO-42924*

## Traveling-Wave Maser for 32 GHz

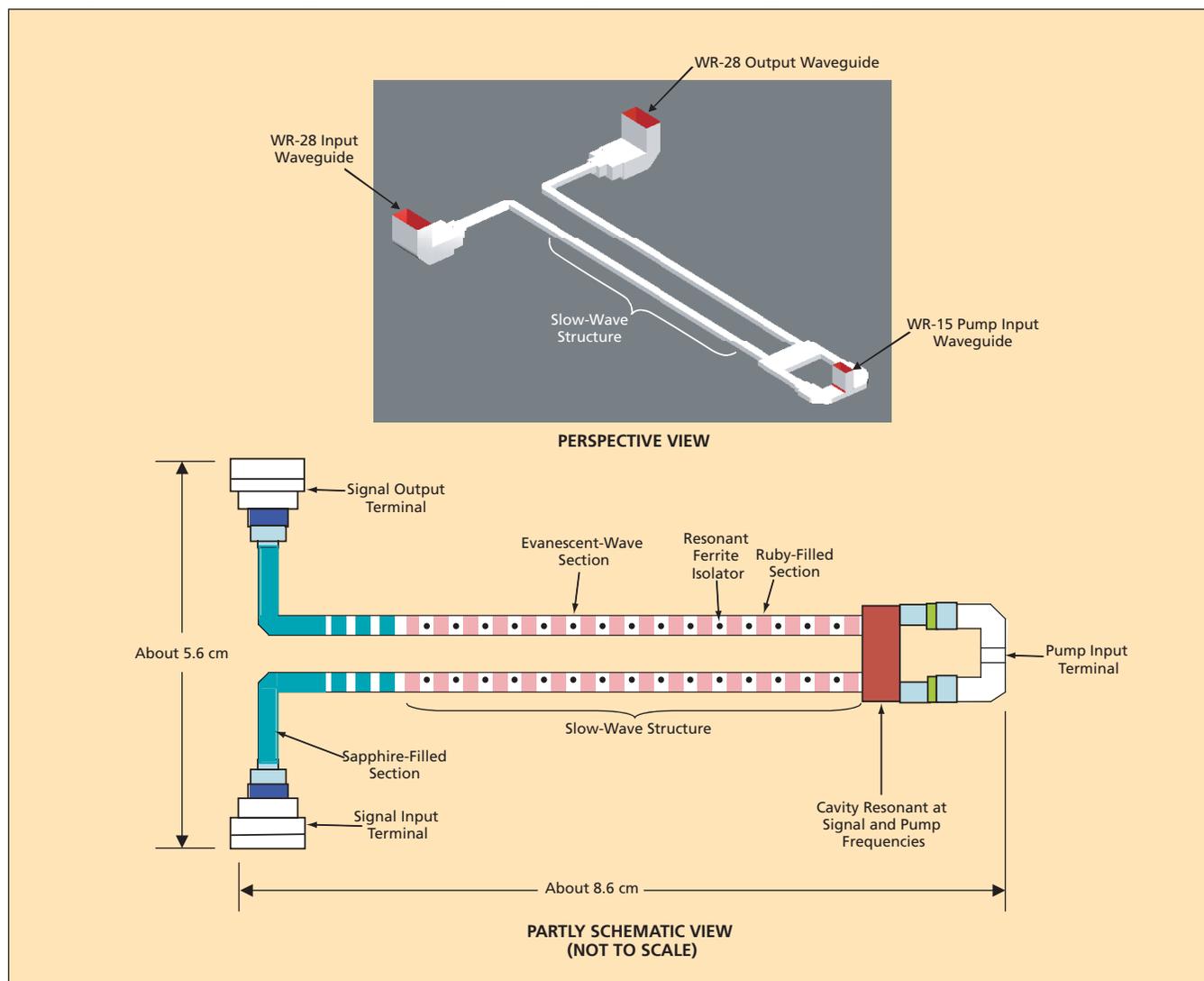
**Significant improvements over prior 32-GHz low-noise amplifiers are anticipated.**

*NASA's Jet Propulsion Laboratory, Pasadena, California*

The figure depicts a traveling-wave ruby maser that has been designed (though not yet implemented in hardware) to serve as a low-noise amplifier for reception of weak radio signals in

the frequency band of 31.8 to 32.3 GHz. The design offers significant improvements over previous designs of 32-GHz traveling-wave masers. In addition, relative to prior designs of 32-GHz ampli-

fiers based on high-electron-mobility transistors, this design affords higher immunity to radio-frequency interference and lower equivalent input noise temperature.



This 32-GHz Maser would include an improved slow-wave structure containing alternating ruby-filled and evanescent-wave sections.