

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

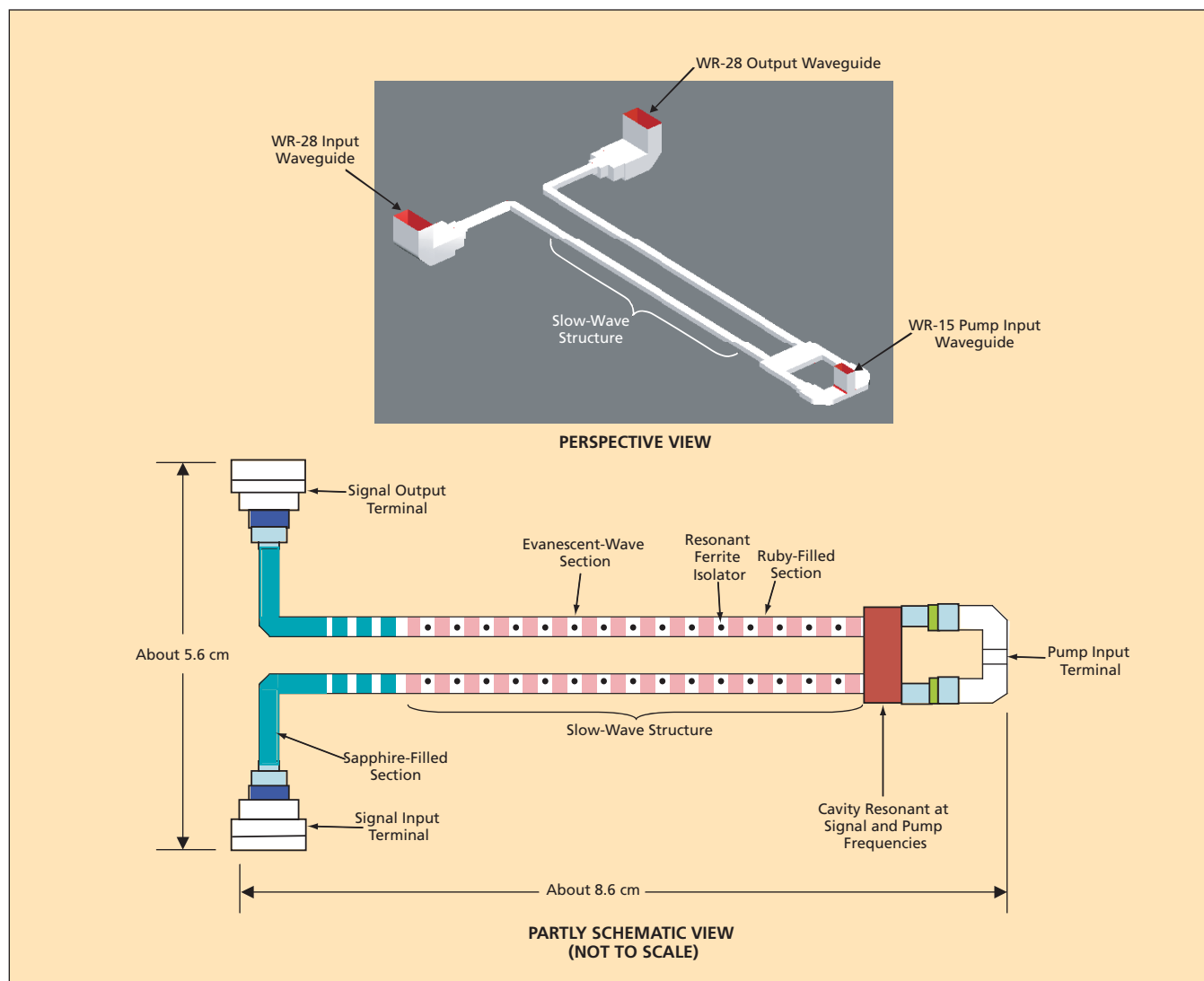
Significant improvements over prior 32-GHz low-noise amplifiers are anticipated.

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.

In addition to the basic frequency-band and low-noise requirements, the initial design problem included a requirement for capability of operation in a closed-cycle helium refrigerator at a temperature ≤ 4 K and a requirement that the design be mechanically simplified, relative to prior designs, in order to minimize the cost of fabrication and assembly. Previous attempts to build 32-GHz traveling-wave masers involved the use of metallic slow-wave structures comprising coupled transverse electromagnetic (TEM)-mode resonators that were subject to very tight tolerances and, hence, were expensive to fabricate and assemble. Impedance matching for coupling signals into and out of these earlier masers was very difficult.

A key feature of the design is a slow-wave structure, the metallic portions of which would be mechanically relatively simple in that, unlike in prior slow-wave structures, there would be no internal metal steps, irises, or posts. The metallic portions of the slow-wave structure would consist only of two rectangular metal waveguide arms. The arms would contain

sections filled with the active material (ruby) alternating with evanescent-wave sections. This structure would be transparent in both the signal-frequency band (the aforementioned range of 31.8 to 32.3 GHz) and the pump-frequency band (65.75 to 66.75 GHz), and would impose large slowing factors in both frequency bands. Resonant ferrite isolators would be placed in the evanescent-wave sections to provide reverse loss needed to suppress reverse propagation of power at the signal frequency.

This design is expected to afford a large gain-bandwidth product at the signal frequency and efficient coupling of the pump power into the paramagnetic spin resonances of the ruby sections. The more efficiently the pump power could be thus coupled, the more efficiently it could be utilized and the heat load on the refrigerator correspondingly reduced. To satisfy the requirement for operation over the 0.5-GHz-wide signal-frequency band, the paramagnetic spin resonances would be broadened by applying a magnetic field having a linear gradient along the slow-wave structure.

The gradients in the two arms are offset in order to compensate for the gaps of the evanescent sections.

The two arms of the slow-wave structure would be connected into a U-shaped assembly. At the base of the U (at the right end in the figure) there would be a cavity that would be simultaneously resonant in the TE_{301} mode at the signal frequency and in the TE_{403} mode at the pump frequency. The pump power would be injected into this cavity that would be beyond cut-off at the signal frequency. The dielectric-filled waveguides that would be excited from the two output arms of an electric-field-plane T junction. The signal power would enter and leave via WR-28 waveguides connected to opposite ends of the U-shaped assembly. Impedance matching would be effected by means of dielectric-filled (sapphire) sections of the waveguide arms near their input and output ends.

This work was done by James Shell and Robert Clauss of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-41273

System Synchronizes Recordings From Separated Video Cameras

A large, immobile timing infrastructure is not needed.

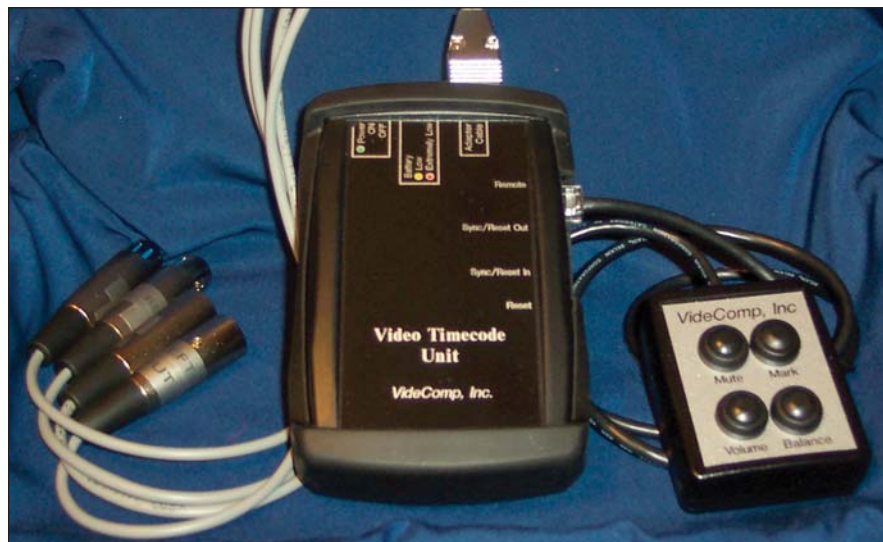
Stennis Space Center, Mississippi

A system of electronic hardware and software for synchronizing recordings from multiple, physically separated video cameras is being developed, primarily for use in multiple-look-angle video production. The system, the time code used in the system, and the underlying method of synchronization upon which the design of the system is based are denoted generally by the term "Geo-TimeCode™." The system is embodied mostly in compact, lightweight, portable units (see figure) denoted video time-code units (VTUs) — one VTU for each video camera. The system is scalable in that any number of camera recordings can be synchronized. The estimated retail price per unit would be about \$350 (in 2006 dollars).

The need for this or another synchronization system external to video cameras arises because most video cameras do not include internal means for maintaining synchronization with other video cameras. Unlike prior video-camera-synchronization systems, this system does not depend on continuous cable or

radio links between cameras (however, it does depend on occasional cable links lasting a few seconds). Also, whereas the time codes used in prior video-camera-synchronization systems typically repeat

after 24 hours, the time code used in this system does not repeat for slightly more than 136 years; hence, this system is much better suited for long-term deployment of multiple cameras.



This **Mockup** of a VTU is based on a prototype VTU circuit powered by a standard 9-volt battery. To the extent possible, production VTUs would be made of low-power, precision electronic components that are already commercially available.