precision in the first place: A white-light phase-conjugate mirror could correct for all the distortions and aberrations in an optical system. The use of white-light phase-conjugate mirrors would be essential for ensuring high performance in optical systems containing lightweight membrane mirrors, which are highly deformable.

As used here, “phase-conjugate mirror” signifies, more specifically, an optical component in which incident light undergoes time-reversal phase conjugation. In practice, a phase-conjugate mirror would typically be implemented by use of a suitably positioned and oriented photorefractive crystal. In the case of a telescope comprising a primary and secondary mirror (see figure) white light from a distant source would not be brought to initial focus on one or more imaging scientific instrument(s) as in customary practice. Instead, the light would be brought to initial focus on a phase-conjugate mirror. The phase-conjugate mirror would send a phase-conjugate image back, along the path of the incoming light, to the primary mirror. A transparent, highly efficient diffractive thin film deposited on the primary mirror would direct the phase-conjugate image to the imaging instrument(s).

This work was done by Donald Frazier and W. Scott Smith of Marshall Space Flight Center, Hossin Abdeldayem of Goddard Space Flight Center, and Partha Banerjee of the University of Dayton. For further information, contact Hossin Abdeldayem at hossin.a.abdeldayem@nasa.gov. MFS-31683-1

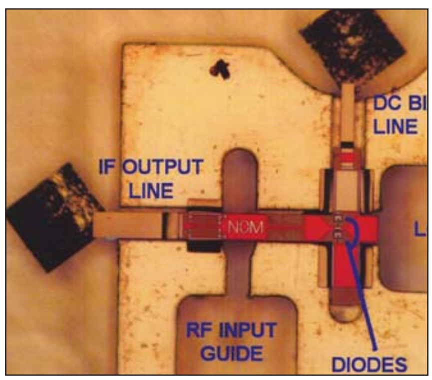
Biasable, Balanced, Fundamental Submillimeter Monolithic Membrane Mixer

Gallium arsenide membrane technology enables wide bandwidth and high operating frequencies.

NASA’s Jet Propulsion Laboratory, Pasadena, California

This device is a biasable, submillimeter-wave, balanced mixer fabricated using JPL’s monolithic membrane process — a simplified version of planar membrane technology. The primary target application is instrumentation used for analysis of atmospheric constituents, pressure, temperature, winds, and other physical and chemical properties of the atmospheres of planets and comets. Other applications include high-sensitivity gas detection and analysis. This innovation uses a balanced configuration of two diodes allowing the radio frequency (RF) signal and local oscillator (LO) inputs to be separated. This removes the need for external diplexers that are inherently narrowband, bulky, and require mechanical tuning to change frequency. Additionally, this mixer uses DC bias-ability to improve its performance and versatility.

In order to solve problems relating to circuit size, the GaAs membrane process was created. As much of the circuitry as possible is fabricated on-chip, making the circuit monolithic. The remainder of the circuitry is precision-machined into a waveguide block that holds the GaAs circuit. The most critical alignments are performed using micron-scale semiconductor technology, enabling wide bandwidth and high operating frequencies. The balanced mixer gets superior performance with less than 2 mW of LO power. This can be provided by a simple two-stage multiplier chain following an amplifier at around 90 GHz. Further, the diodes are arranged so that they can be biased. Biasing pushes the diodes closer to their switching voltage, so that less LO power is required to switch the diodes on and off.



In the **Balanced Mixer**, the diodes are at the right side of the circuit and the LO comes from the waveguide at the right into a reduced-height section containing the diodes. The RF signal is picked up from the RF waveguide by the probe on the left, and flows rightward to the diodes.

In the photo, the diodes are at the right end of the circuit. The LO comes from the waveguide at the right into a reduced-height section containing the diodes. Because the diodes are in series to the LO signal, they are both turned on and off simultaneously once per LO cycle. Conversely, the RF signal is picked up from the RF waveguide by the probe at the left, and flows rightward to the diodes. Because the RF is in a quasi-TEM (suspended, microstrip-like) mode, it impinges on the diodes in an anti-parallel mode that does not couple to the waveguide mode. This isolates the LO and RF signals. This operation is similar to a cross-bar mixer used at low frequencies, except the RF signal enters through the back-short end of the waveguide rather than through the side. The RF probe also conveys the down-converted intermediate frequency (IF) signal out to an off-chip circuit board through a simple LC low-pass filter to the left as indicated. The bias is brought to the diodes through a bypass capacitor at the top.

This work was done by Peter Siegel, Erich Schlecht, Imran Mehdi, John Gill, James Velebir, Raymond Tsang, Robert Dengler, and Robert Lin of Caltech for NASA’s Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. NPO-44698