# Local Leak Detection and Health Monitoring of Pressurized Tanks

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An optical gas-detection sensor safely monitors pressurized systems (such as cryogenic tanks) and distribution systems for leaks. This sensor system is a fiber-coupled, solid optical body interferometer that allows for the miniaturized sensing element of the device to be placed in the smallest of recesses, and measures a wide range of gas species and densities (leaks). The deflection of the fringe pattern is detected and recorded to yield the time-varying gas density in the gap. This technology can be used by manufacturers or storage facilities with toxic, hazardous, or explosive gases.

The approach is to monitor the change in the index of refraction associated with low-level gas leaks into a vacuum environment. The completion of this work will provide NASA with an enabling capability to detect gas system leaks in space, and to verify that pressurized systems are in a safe (i.e. non-leaking) condition during manned docking and transit operations.

By recording the output of the sensor, a time-history of the leak can be constructed to indicate its severity. Project risk is mitigated by having several interferometric geometries and detection techniques available, each potentially leveraging hardware and lessons learned to enhance detectability.

*This work was done by Kurt Polzin and William Witherow of Marshall Space Flight Center; Valentin Korman formerly of Madison Research Corp; John Sinko of Kratos Defense; and Adam Hendrickson of the U.S. Army. For more information, contact Sammy Nabors, MSFC Commercialization Assistance Lead, at sammy.a.nabors@nasa.gov. Refer to MFS-32584-1.*

# Dielectric Covered Planar Antennas at Submillimeter Wavelengths for Terahertz Imaging

## This technology has potential uses for terahertz radar imagers, radiometers, and spectrometers for earth-science observing instruments.

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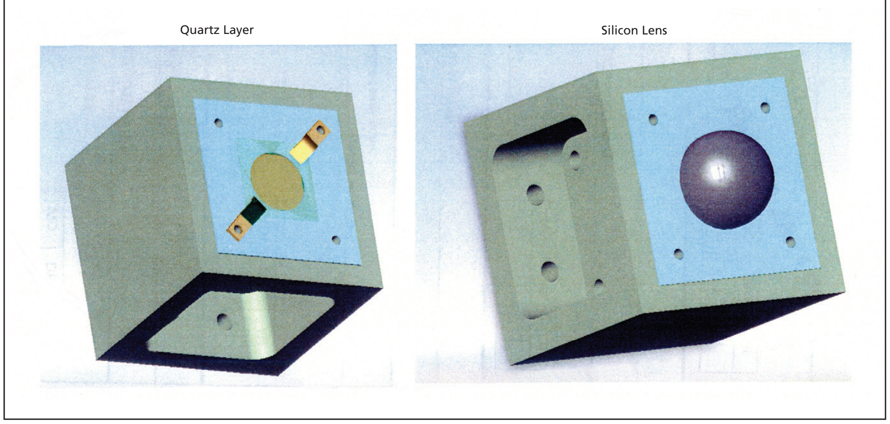
Most optical systems require antennas with directive patterns. This means that the physical area of the antenna will be large in terms of the wavelength. When non-cooled systems are used, the losses of microstrip or coplanar waveguide lines impede the use of standard patch or slot antennas for a large number of elements in a phased array format.

Traditionally, this problem has been solved by using silicon lenses. However, if an array of such highly directive antennas is to be used for imaging applications, the fabrication of many closely spaced lenses becomes a problem. Moreover, planar antennas are usually fed by microstrip or coplanar waveguides while the mixer or the detector elements (usually Schottky diodes) are coupled in a waveguide environment. The coupling between the antenna and the detector/mixer can be a fabrication challenge in an imaging array at submillimeter wavelengths.

Antennas excited by a waveguide (TE10) mode makes use of dielectric superlayers to increase the directivity. These antennas create a kind of Fabry-Perot cavity between the ground plane and the first layer of dielectric. In reality, the antenna operates as a leaky wave mode where a leaky wave pole propagates along the cavity while it radiates. Thanks to this pole, the directivity of a small antenna is considerably enhanced.




The **Waveguide Block** with the quartz layer (left) and the silicon lens (right).

The antenna consists of a waveguide feed, which can be coupled to a mixer or detector such as a Schottky diode via a standard probe design. The waveguide is loaded with a double-slot iris to perform an impedance match and to suppress undesired modes that can propagate on the cavity. On top of the slot there is an air cavity and on top, a small portion of a hemispherical lens. The fractional bandwidth of such antennas is around 10 percent, which is good enough for heterodyne imaging applications.

The new geometry makes use of a silicon lens instead of dielectric quarter wavelength substrates. This design presents several advantages when used in the submillimeter-wave and terahertz bands:

- Antenna fabrication compatible with lithographic techniques.
- Much simpler fabrication of the lens.
- A simple quarter-wavelength matching layer of the lens will be more efficient if a smaller portion of the lens is used.
- The directivity is given by the lens diameter instead of the leaky pole (the bandwidth will not depend anymore on the directivity but just on the initial cavity).

The feed is a standard waveguide, which