value (in the present example, 15 °C) below the chamber temperature by the same fixed amount. Modeling shows that the resulting symmetry in the temperature differential, in combination with the geometric symmetry of the apparatus, serves to ensure that heat escaping from the edge of the heated disk flows through the air-gap region and, for the most part, returns to the edge of the cooled disk. It also ensures that the heat escaping from the half of the guard ring that is positioned toward the heated disk flows to the half of the guard ring positioned towards the cooled disk. This helps to assure one-dimensional heat flow through the sample, thereby minimizing the measurement errors. The time-averaged heater power needed to maintain the specified constant temperature of the heated disk in the steady state is what is measured.

The following description of the theory of operation and the calculation of thermal conductivity from measurement data is somewhat simplified for the sake of brevity. The heater power is nominally given by

$$Q = kA\Delta T/l + Q_L,$$

where k is the thermal conductivity of the sample material under test, A is the cross-sectional area of the sample (nominally, the area of the circle enclosed by the guard ring), ΔT is the specified difference between the temperatures of the heated and cooled disks, l is the thickness of the sample, and Q_L is the rate of leakage of heat along all paths other than that of direct one-dimensional thermal conduction through the thickness of the sample.

Modeling shows that the combination of temperature-differential and geometric symmetry and the one-dimensional heat flow through the sample ensures that the heat-leakage power is essentially independent of the sample material. Hence, it is possible to determine the value of Q_L as a function of the heated disk, cooled disk, and chamber wall temperatures from calibration measurements on one or more specimens having known thermal conductivities. Modeling also shows that the device may be calibrated using air as the reference standard material. Thereafter, one can use the value of Q_L as thus determined to calculate values of k from measured values of Q.

This work was done by Robert A Miller and Maria A Kuczmarski of Glenn Research Center. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18356-1.

Alignment Jig for the Precise Measurement of THz Radiation

This device can be used by optometrists to measure aberrations in lenses, and by head-mount display manufacturers.

NASA's Jet Propulsion Laboratory, Pasadena, California

An alignment jig (see figure) places a THz horn and power detector at the proper locations with respect to the focal points of a conic reflector in order to couple total power of the THz source radiating out of its horn into the power detector for precise measurement of its power. A visible laser beam locates focal points of the conic reflector. Measuring total diverging power from a THz point source is not an easy task. THz radiation has a wavelength range of between 0.1 and 1 mm. The power levels range from a few tens of nW to 100 mW. These power levels are low, and low temperatures (in the range of –173 °C) are typically used to house the THz power source. Because of the small target, the power emitter and the power detectors must be located in exact positions in order to fully capture the radiated energy. At these low powers, there are three common commercial power meters: a bolometer detector, a Golay Cell, and a Keating Meter. These three power meters have specific power ranges where they excel, and they must be calibrated at their overlapped power ranges. Because of the low THz power being measured, conical reflectors are used to send all of the radiated power to the detectors.

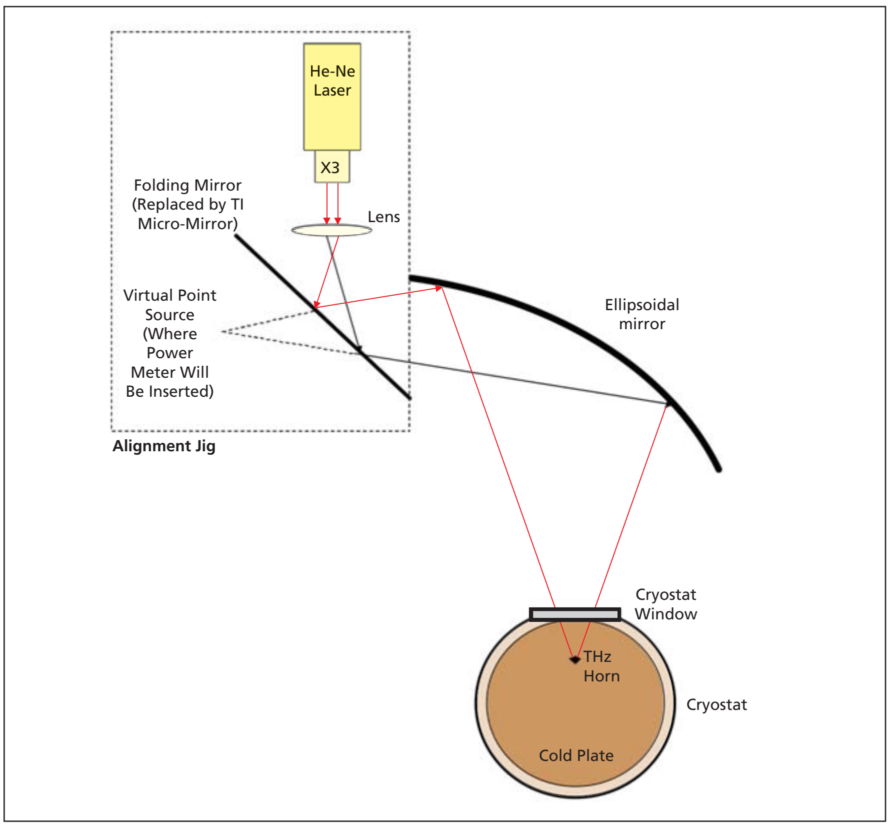

Figure 1. The **Alignment Jig** for measurement of THz power employs an ellipsoidal mirror with a THz horn at one focal point and the power meter at the second focal point.

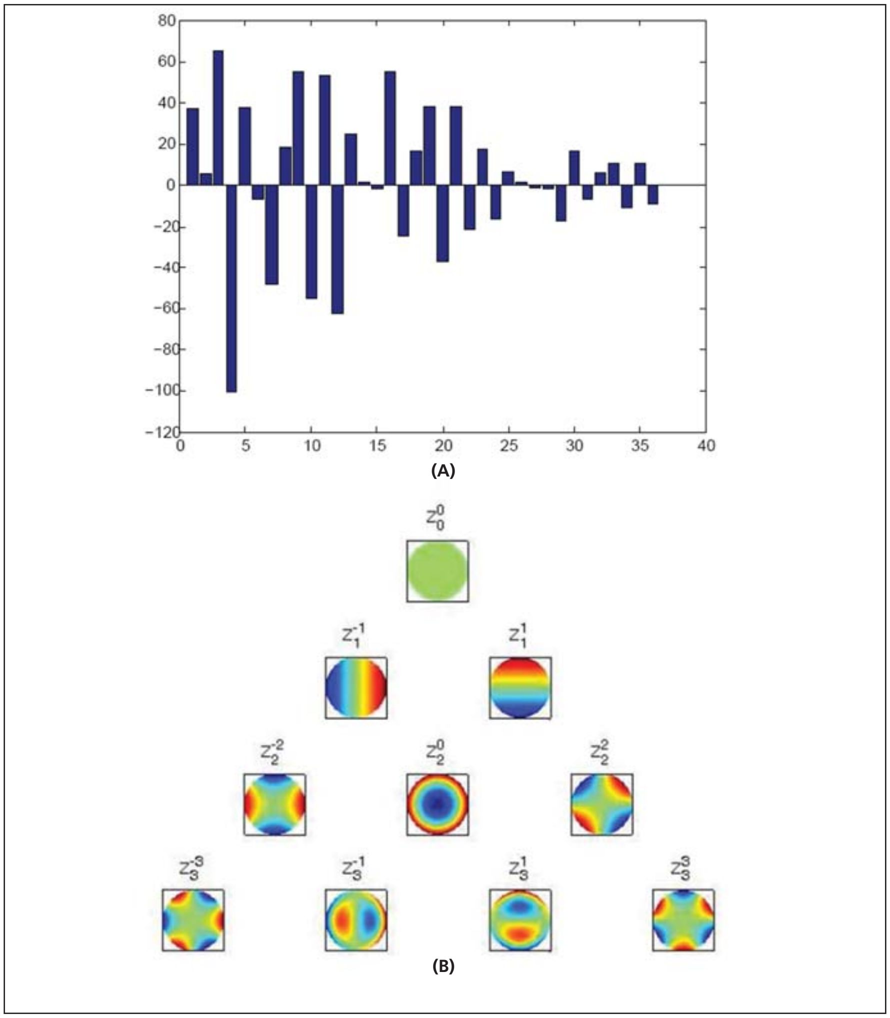

Figure 2. (a) **Quantification of Optical Aberration** as intorduced by an arbitrary lens is manifested by amplitude of its Zernicke coefficients specified in the order of (*n*= 0, 1, 2, 3, etc.: *m*=–*n*, . . . ,0, . . . , *n* if *n* even ; –*n*, . . . , *n* if *n* odd). (b) First 10 individual Zernicke functions are plotted.

These reflectors focus the energy of the THz source, and the detectors are placed at a convergent focal point to capture the radiated THz power.

One cannot place the detectors just by approximating by eye. THz waves are submillimeter, and require precise placement. The method proposed here is to use a visible low-power red laser (630 nm) with a 1-mm beam diameter (see Figure 1). The laser is beamed through a 3× beam expander to obtain a circular beam, then through a lens in order to focus the beam onto a TI DLP micro-mirror at an angle. This mirror bounces the laser light onto an ellipsoidal mirror that will focus it into a point. That is the point where the THz source is to be placed.

The initial focal point (laser source) is marked in 3D space as if the TI micro-mirror wasn't there. This virtual focal point is where the detector is to be placed. Since a circular beam is used, it is easier to locate the focal points by watching for the bright red spot that signals beam convergence.

Once the two focal points are found, and the energy source and energy detectors are in place, it is necessary to check calibration. Array of circular patterns can be beamed from the DLP chip to evaluate Zernike's refraction aberrations in real time (see Figure 2). In addition, various diagnostic patterns can be beamed from the DLP chip in order to measure aberrations associated with field variation. For example, a spot diagram can be beamed off of the DLP in order to analyze point spread.

This method is useful for the semiconductor industry to evaluate surface metrology of thin transparent optics, clinical optometry to measure lens aberration, telescopes and astronomical receivers to align mirrors covering optics and radiation sources, and head-mount displays to evaluate beam splitters.

This work was done by Hamid H. Javadi of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

Autoignition Chamber for Remote Testing of Pyrotechnic Devices

This rugged, reusable chamber is portable and can remotely heat pyrotechnics for autoignition tests.

Lyndon B. Johnson Space Center, Houston, Texas

The autoignition chamber (AIC) performs by remotely heating pyrotechnic devices that can fit the inner diameter of the tube furnace. Two methods, a cold start or a hot start, can be used with this device in autoignition testing of pyrotechnics. A cold start means extending a pyrotechnic device into the cold autoignition chamber and then heating the device until autoignition occurs. A hot start means heating the autoignition chamber to a specified temperature, and then extending the device into a hot autoignition chamber until autoignition occurs. Personnel are remote from the chamber during the extension into the hot chamber.

The autoignition chamber, a commercially produced tubular furnace, has a 230-V, single-phase, 60-Hz electrical supply, with a total power output of 2,400 W. It has a 6-in. (15.2-cm) inner diameter, a 12-in. (30.4-cm) outer diameter and a 12-in.-long (30.4-cm), single-zone, solid tubular furnace (element) capable of heating to temperatures up to 2,012 °F (1,100 °C) in air. The furnace temperature is controlled by a commercial single-zone, setpoint temperature controller and solid-state relay.

The furnace features a stainless steel shell with 1/4-in.-thick (6-mm) steel end plates, and a rugged insulation package. A thermocouple port is supplied in the center of the control zone.