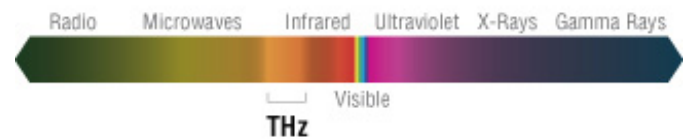


# Leading the way in Terahertz Technology

## What is Terahertz (THz)?

Terahertz radiation is part of the electromagnetic spectrum lying between microwaves and the far-IR. This region has frequencies ranging from 0.1 – 10 THz and wavelengths from 3 mm to 0.03 mm. This spectral region is often referred to as the “Terahertz gap” as these frequencies fall between electronic (measurement of field with antennas) and optical (measurement of power with optical detectors) means of generation. Over the past 20 years, TeraMetrix has developed advanced techniques and equipment to explore and exploit this region of the spectrum.



## Applications of Terahertz

### Industrial process control and non-destructive testing

By building ruggedized systems, pulsed terahertz has been used for high precision gauging of products in continuous manufacturing or in coating thickness measurement.

Some of the measurements made are:

- Density
- Basis weight
- Structural integrity
- Single and multilayer thickness
- Product uniformity
- Coating thickness

### Imaging through material

Similar to x-ray images, terahertz wavelengths penetrate through most non-conductive materials and can easily reveal imperfections such as voids, cracks, and density variations. Terahertz offers a significant advantage over x-rays because the radiation is non-ionizing and thus is completely safe. Example imaging applications include flaw detection in the sprayed-on-foam-insulation (SOFI) for the space shuttle program, detection of flaws in composite materials and detection of the underlying construction of ancient panel paintings.

### Spectroscopic measurements

Time-domain pulsed terahertz energy sources contain broadband frequency content. Thus, spectroscopic determinations (fingerprints) are possible allowing the identification of objects of interest (e.g., explosives, biological agents). Using spectroscopic features to generate images is an especially powerful application of terahertz. The energies of terahertz photons allow the probing and study of low energy transitions (molecular rotations, protein folding, phonons in solid state materials, electrical circuit characteristics).

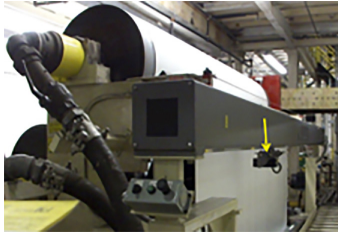
Advances in terahertz spectroscopic analysis includes innovations in the following areas:

- Threat material detection (e.g., explosives, weapons)
- Environmental sensing (especially gas detection)
- Biomedical applications (e.g., skin cancer detection)
- Moisture content in consumer products

## About TeraMetrix

TeraMetrix is meeting the needs of the industrial, non-destructive testing, and research markets. Established in 1992 as Picometrix, they developed the first commercially available terahertz system. Luna acquired Picometrix in 2015 and re-branded the company as TeraMetrix. Now manufacturing its 5th generation terahertz system, TeraMetrix is the world leader in deployment of pulsed terahertz equipment for online gauging. Deployed globally in factories manufacturing everything from pharmaceuticals to asphalt shingles, their products are recognized as the most advanced pulsed terahertz systems on the market. TeraMetrix systems have also been qualified by the U.S. Department of Defense for use in quality control of multiple specialty aircraft.

## Industrial Deployment Process Control



THz is used to control the thickness of both layers of TPO roofing and detect delamination between the layers. Top layer flatness to  $\pm 0.25$  mils  $3\sigma$  has been achieved with auto die control.

Two THz sensors can be deployed to measure the total thickness and balance of both textile and steel cord tire ply. Calibration factors for gum formulation were shown to be stable over 4 months of operation on multiple products. Layer flatness increases could lead to savings

of over \$1M per year.

High precision measurements allow control of adhesive layer application as thin as 25 microns.

THz sensors are measuring thickness and density of adhesive foams online with a single sensor.



### PRODUCT SPOTLIGHT: Standard Online Sensor Head (HXC50yn)

The HXC50yn Online Sensor Head is a robust, factory hardened transceiver for the T-Ray® 5000 terahertz system. Reflection measurement of thickness, multi-layer thickness, and basis weight are easily acquired. A variety of lenses are available to adjust the measurement spot size and working distance (1, 3 and 6 inch).

The HXC50yn provides sufficient bandwidth to measure layer thicknesses down to 50 microns.



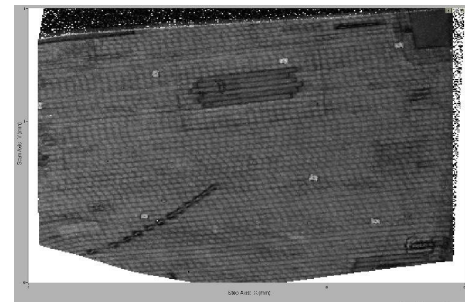
## Non-Destructive Testing



Handheld THz sensors can measure the specialty coatings on advanced airframes. Gauge R&R gives a total gauge of  $\pm 0.15$  mils and a 9% precision to tolerance ratio. Far superior to eddy current or magnetic sensors.

The internal structure of composite radomes can be visualized using robot mounted THz sensors for automated repair operations. Location and depth information is available.

Handheld scanners can show real time internal structure to locate subsurface fasteners or defects. Panel flush and gap can also be automatically measured and reported to the screen.



### PRODUCT SPOTLIGHT: Line Scan Gauge (LSG500n)



The LSG expands the utility of the handheld by scanning the beam along a 2 or 3-inch line, providing a real time cross-sectional image (b-scan) of the object under test. The individual waveforms can still be analyzed to provide layer measurements, and individual b-scan images or b-scan videos can be captured. The LSG can measure layers down to 50 microns.