Modulo Uno

Streamlined and Versatile Laser NDT Inspection
All Surface Types

LASER ULTRASONICS FOR NON-DESTRUCTIVE TESTING

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The Modulo Uno is a laser interferometer featuring a streamlined version of our rugged **Multi-Channel Random Quadrature (MCRQ) optical design**. Unlike its big brother the Quartet which uses two detector arrays to register the vertically and horizontally polarized components independently, the Modulo Uno is fitted with a single detector. But it isn't just a mini quartet. Because the probe beam does not need to be split in half, the Modulo can operate using a lower powered laser. This makes the instrument not only less expensive to build but allows for testing on sensitive materials such as composites (without a beam chopper) and ideal for Bio-medical applications.

Robust & Versatile
The Modulo does not require high accuracy optical components or positioning, making it exceptionally rugged.

Fiberized Optical Head
A versatile fiberized optical head is easily mounted to fit a variety of measurement conditions and can be set-up for a wide-range of stand-off distances.

Precision
The Modulo produces both an analog and digital signal proportional to surface displacement.

High Sensitivity on all Surface Types and Materials
A detector array together with high transmission optics result in high sensitivity. The Modulo produces a stable, demodulated signal even when processing a highly speckled beam. Measurements can be performed on any kind of surface, including rough, porous, rusted and mirror-like.

Rapid Inspection
Efficient electronic processing allows for measurement speeds up to meters per second (with rectified demodulation).

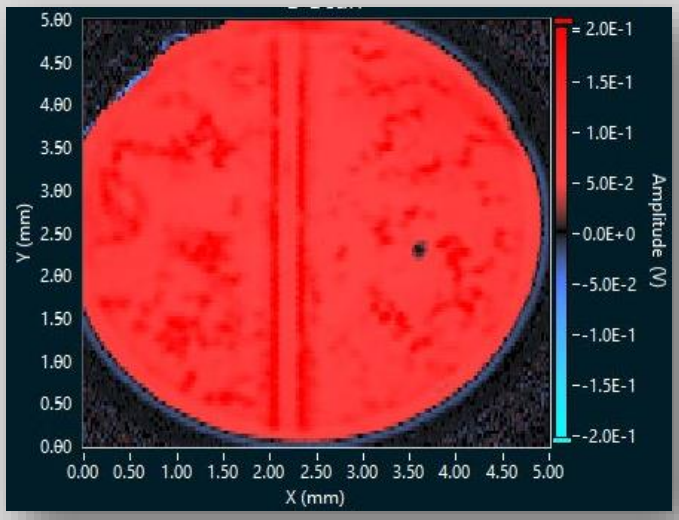
Not Wavelength Dependent
The Modulo can be fitted with a range of internal laser wavelengths ranging from visible to infrared.

Example of Application: Transducer Characterization

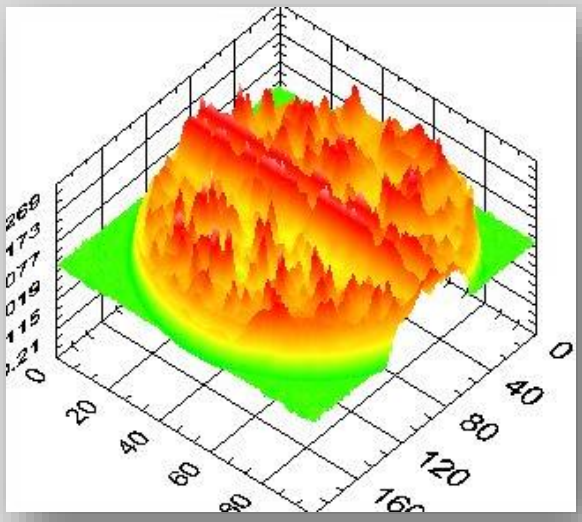
Visible Non-uniform Surface Displacement

- Direct Laser Ultrasonic Measurement
- Stand-off distance =100mm
- 5MHz Piezo with Pulse excitation (50Vpp).
- ≈ 4nm peak-to-peak surface displacement.
- Modulo:
  - 30mW laser output with a wavelength of 1064 nm.
  - NESD* on Piezo: ~ $5 \cdot 10^{-5}\, nm/\sqrt{Hz}$.

C-Scan



3D Surface



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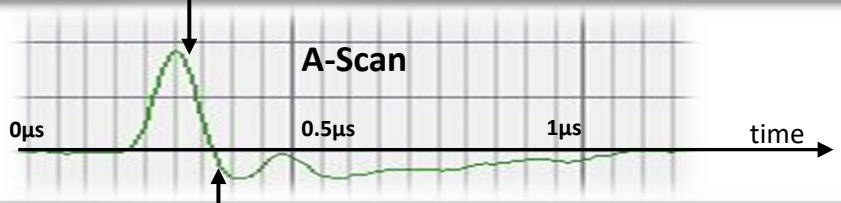

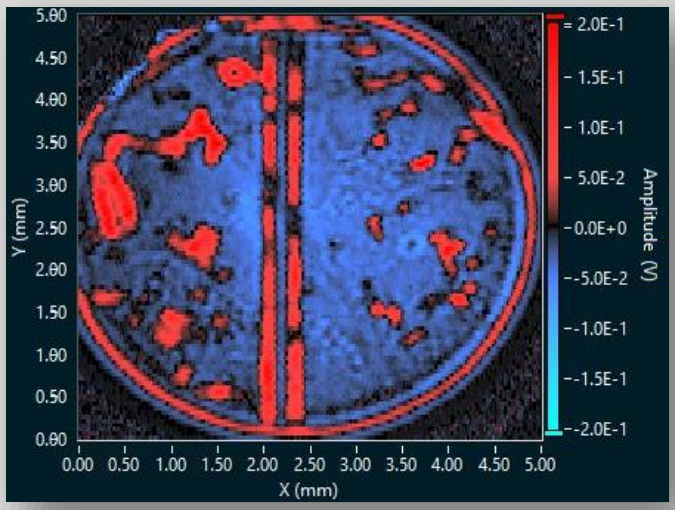

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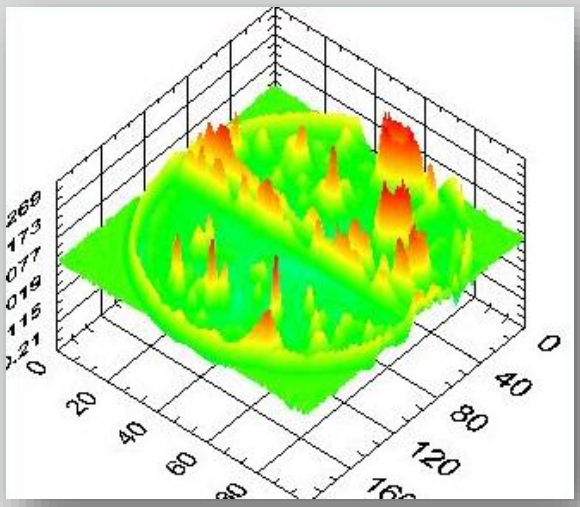

* *NESD: Noise Equivalent Surface Displacement*

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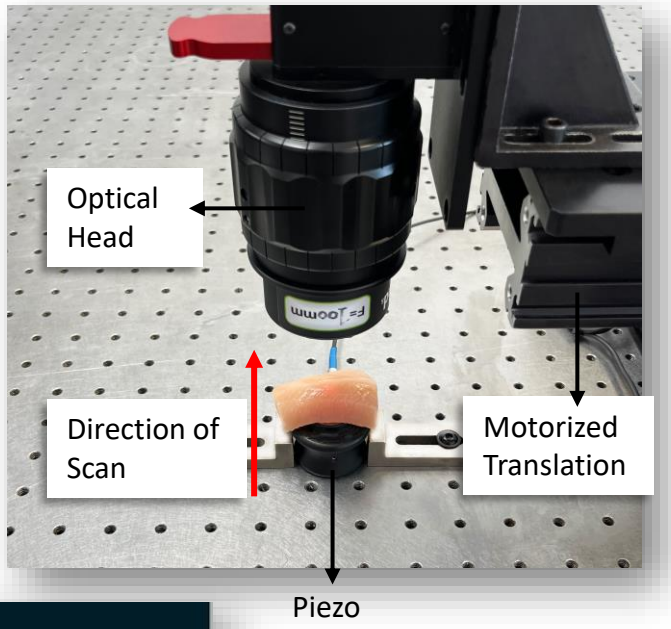
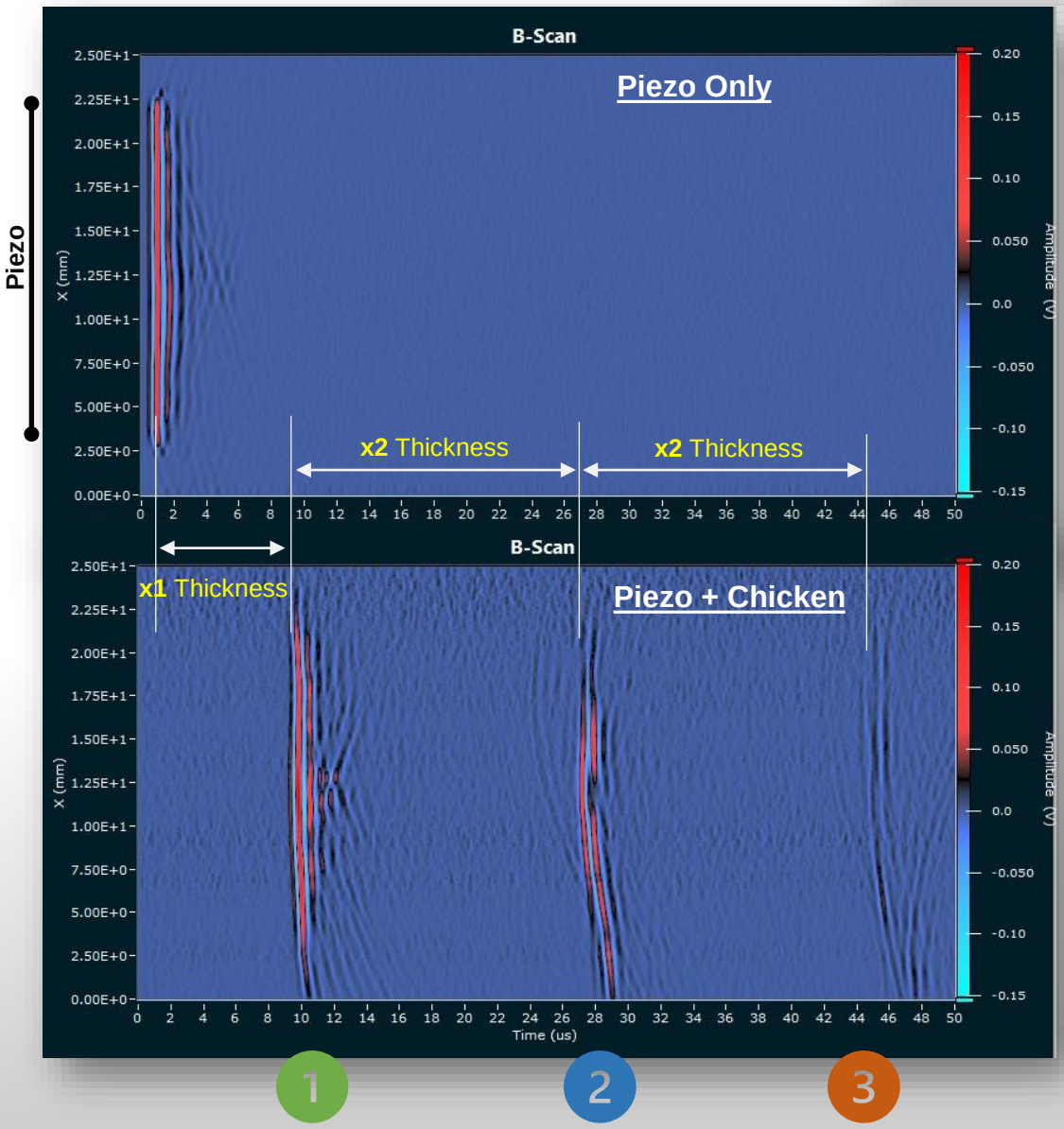
Example of Application: Animal Tissue Scan

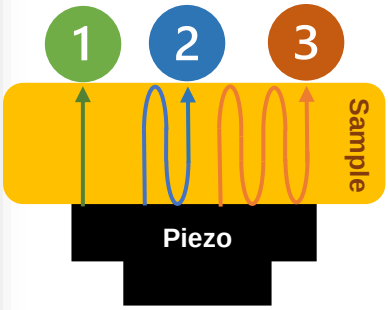
- Through transmission experiment
- Stand-off distance =100mm
- 2.25MHz Piezo, 0.75" diameter
- Pulse excitation (50Vpp)
- Sample: Chicken breast, thickness ~ 12mm
- Corresponding surface displacement ~4nmpp
- Line scan across Piezo (+chicken)
- Modulo-Uno:

  Laser output: 30mW @ λ=1064 nm

  NESD on chicken breast: ~ $62 \cdot 10^{-6}\, nm/\sqrt{Hz}$.







1 Direct Transmission Wave

2 1St Reflection Wave

3 2nd Reflection Wave

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MCRQ Technology: The idea behind Multi-Channel Random Quadrature was to develop a laser-ultrasound technology with a robust, compact design and a large depth-of-field capable of functioning effectively in a wide range of environments without loses in sensitivity, including on rough surfaces. With support from the National Science Foundation and NASA, we developed a novel interferometric design. By collecting and processing a multitude of speckles, the Modulo is fully functional in environments which would otherwise be unsuitable for most other laser ultrasound instruments.

NESD (Noise Equivalent Surface Displacement)	The NESD varies based on the material composition and measurement setup. At 30mW and 1064nm with a stand-off distance of 100mm on an Aluminum target, the NESD = $22 \cdot 10^{-6}\, nm/\sqrt{Hz}$.
Standard Detection Bandwidth	440K – 20M Hz
Laser Output	30 – 100 mW
Laser wavelength	532nm (Visible), 1064nm (IR)
Fiber	Multimode / Length does not affect performance
Spot diameter on sample	50µm to 1.5mm (depend on stand-off & wavelength)
Optical stand-off	From 70mm to a few meters
Diameter of collecting aperture	2” (50mm) for standard optical head
Analog Outputs	Calibrated output – 100mV/nm Direct output, Calibration level and DC level
Digital Output	Sampling Rate 125 Ms/s Resolution 8 Bits Ethernet Output Rate 1Gbit/s
Options	2D scanning set-up including PC, software, and X-Y translations
Demodulation Dimensions	400 x 170 x 165 mm
Optical Head Dimensions	65 x 85 x 170 mm
Demodulation Weight	6.5 kg
Optical Head Weight	0.75 kg