Structural Health Monitoring for Life Management of Aircraft

- SHM of Adhesively-bonded Composites -

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FAA Sponsored Project Information

- **Principal Investigators & Researchers**
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- **FAA Technical Monitor**
  - Curt Davies

SHM of Adhesively-bonded Composites

- **Motivation:**

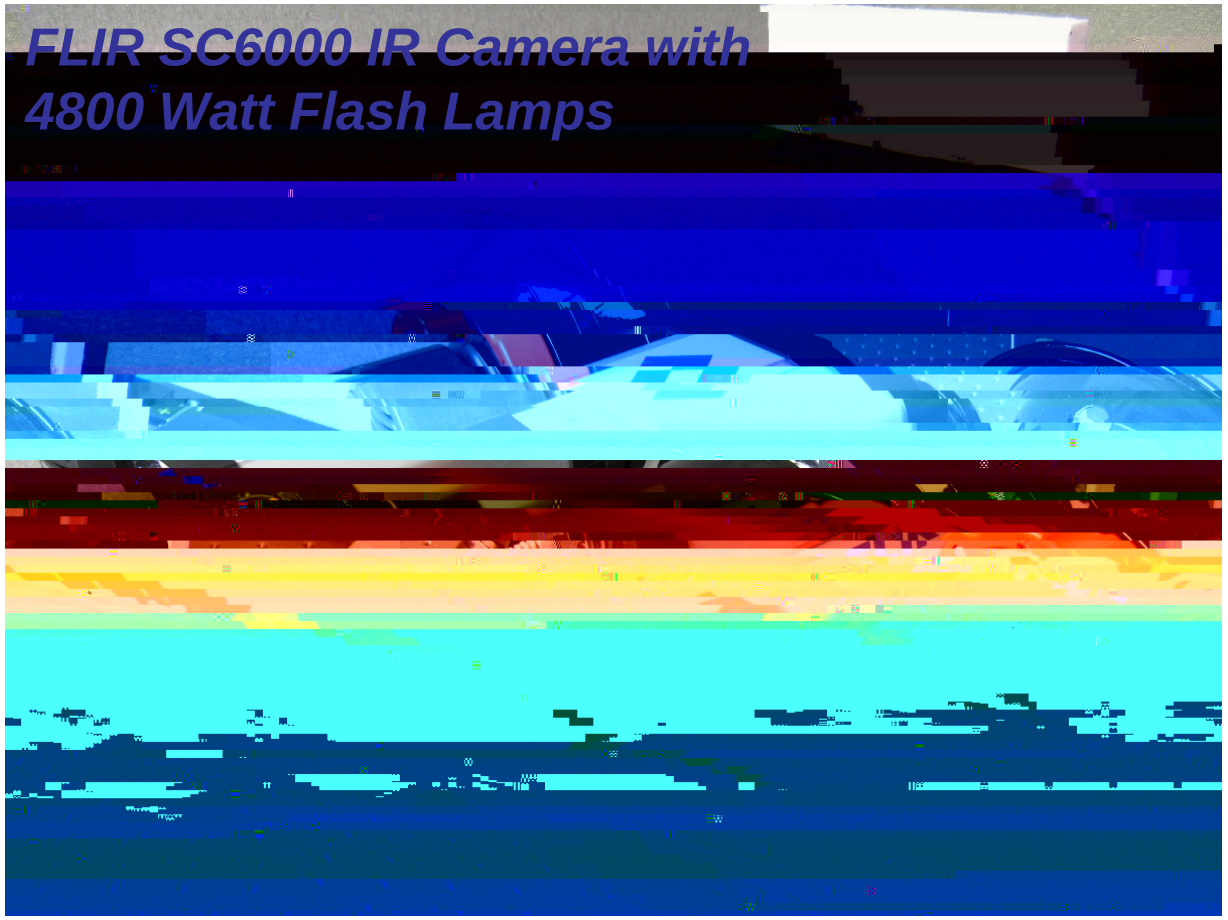
  Structural degradation of advanced aircraft composites caused by environment and service loads (fatigue, corrosion etc) or unpredictable external events (impact etc).

- **Goal:**

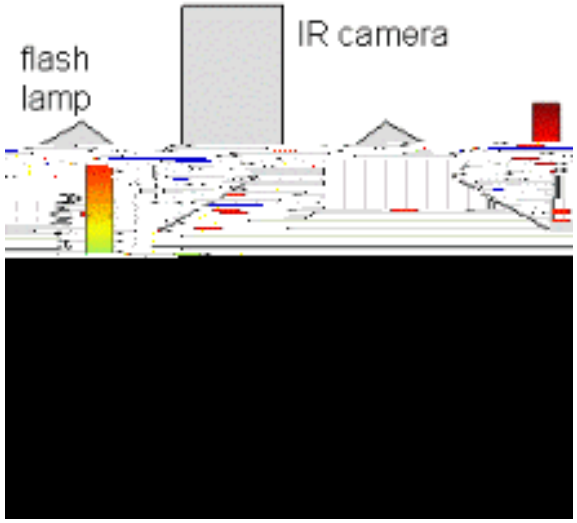
GLARE Laminates

- Glass-Reinforced (GLARE) laminate is a new class of fiber

Thermal Imaging Setup (Pulsed Thermography)

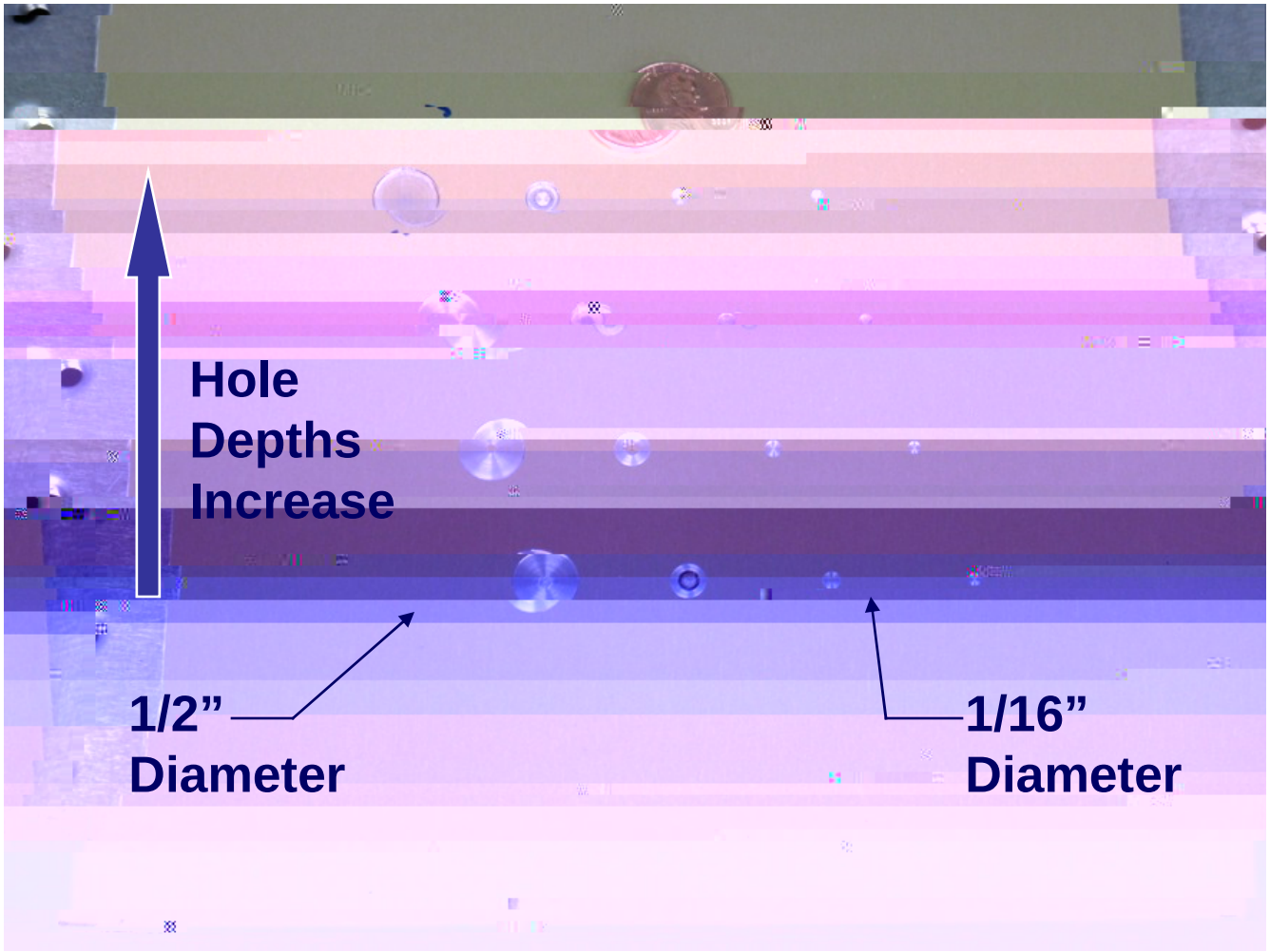


Setup at Northwestern University

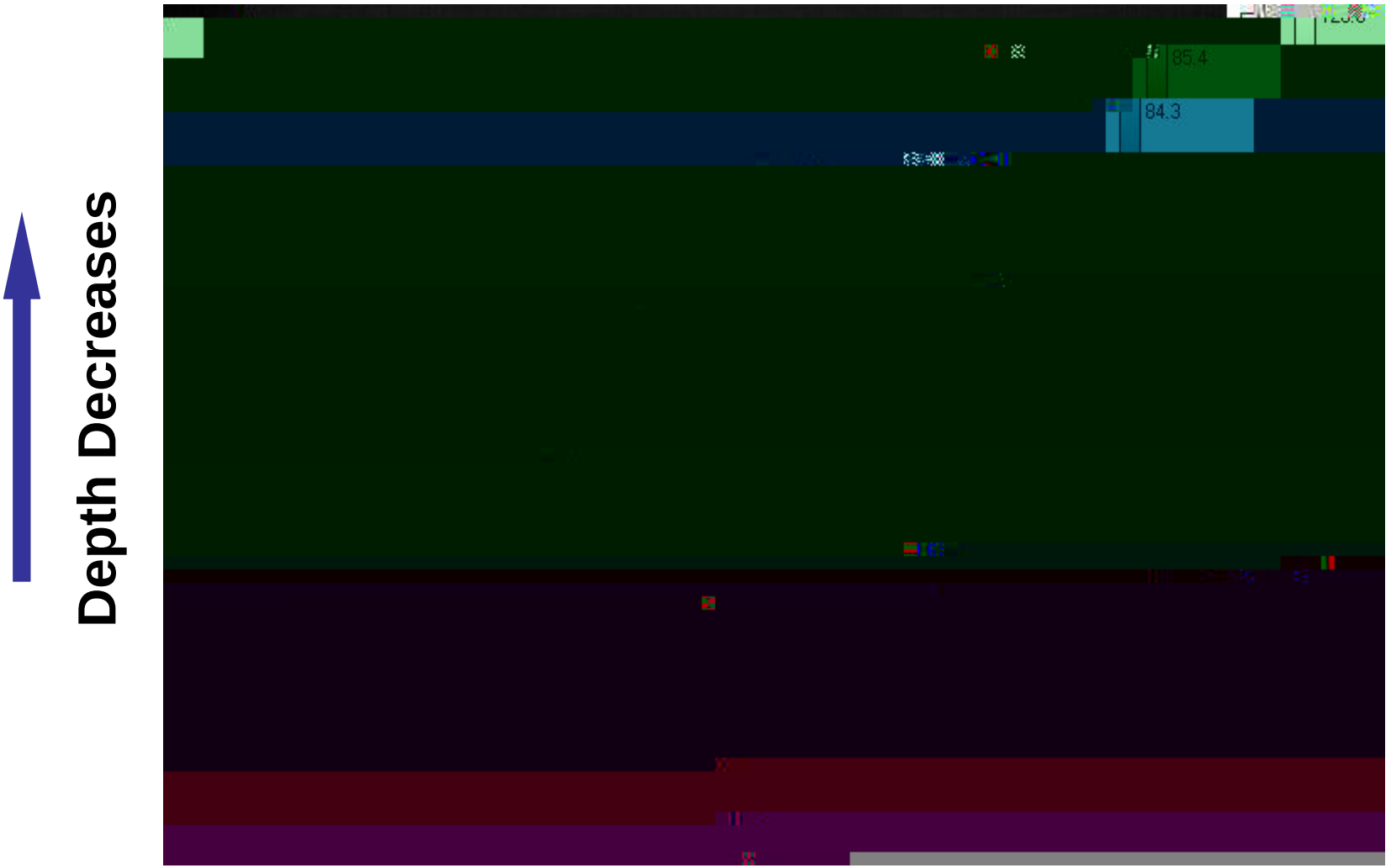


Animation Courtesy of Thermal Wave Imaging, Inc.

Thermal Imaging GLARE Standard



Thermal Image of GLARE Standard (Through Transmission)



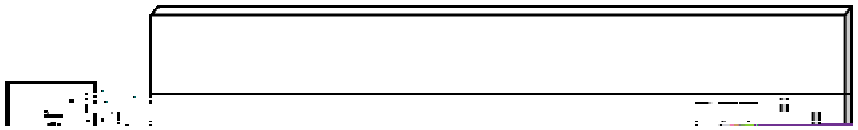
Thermal Image of GLARE Standard (Single Sided)

Depth Decreases

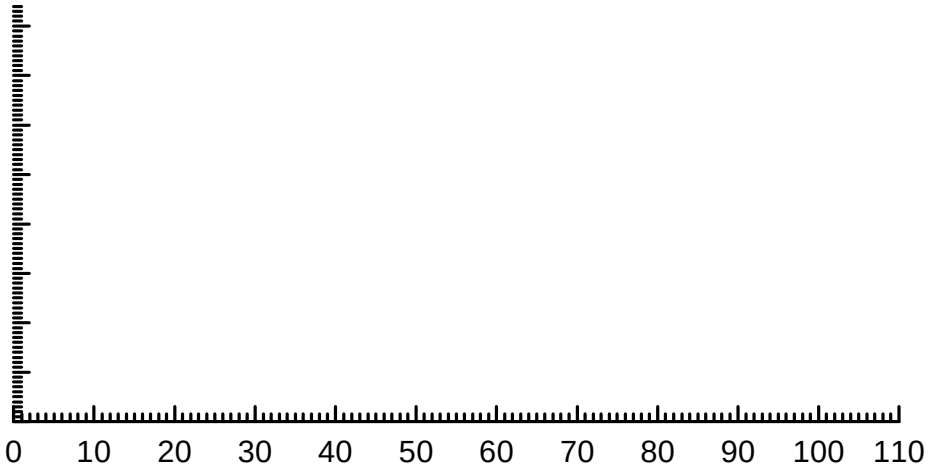
Thermal Image of GLARE Standard (Through Transmission)

Tab. 1: Mechanical properties of the 2024 T3 aluminum alloy

Setup for Lamb-wave Launching with a Pulsed Laser



Measured Lamb-wave Signals



Fabrication of PZT Interdigital Transducers (IDTs)

Two transducers were developed with photolithography technique:

- A thin layer of photoresist (AZ1518) was spin coated on a PZT piece and then baked on a hot plate at 95 ^{o}C for 2 minutes.
- The PZT piece was subsequently subjected to expose under ultraviolet (UV) light with a Q2000 mask aligner.
- After exposure, the PZT sample was developed in a developer (AZ 400K) to remove the exposed photoresist.
- The developed specimen was dipped into Ferric Chloride to etch away the unwanted nickel area.
- As a result, the designed pattern was then successfully transferred to the PZT electrode after cleaning off the remained photoresist with Acetone.

Fig. 6: (a) Electrode pattern design for the interdigital transducer with finger spacing of Λ=2.363 mm and finger width of 20% Λ; (b) Electrode pattern on a PZT transducer fabricated with photolithography (Dark areas: Nickel electrodes).

Excitation Signal

The excitation sinusoidal signal with Hanning window was chosen in the form of:

$$y(t) = \begin{cases} 0.5[1-\cos(2\pi f_0 t / n_0)]\cos(2\pi f_0 t), & t \le n_0 / f_0 \\ 0, & t > n_0 / f_0, \end{cases}$$

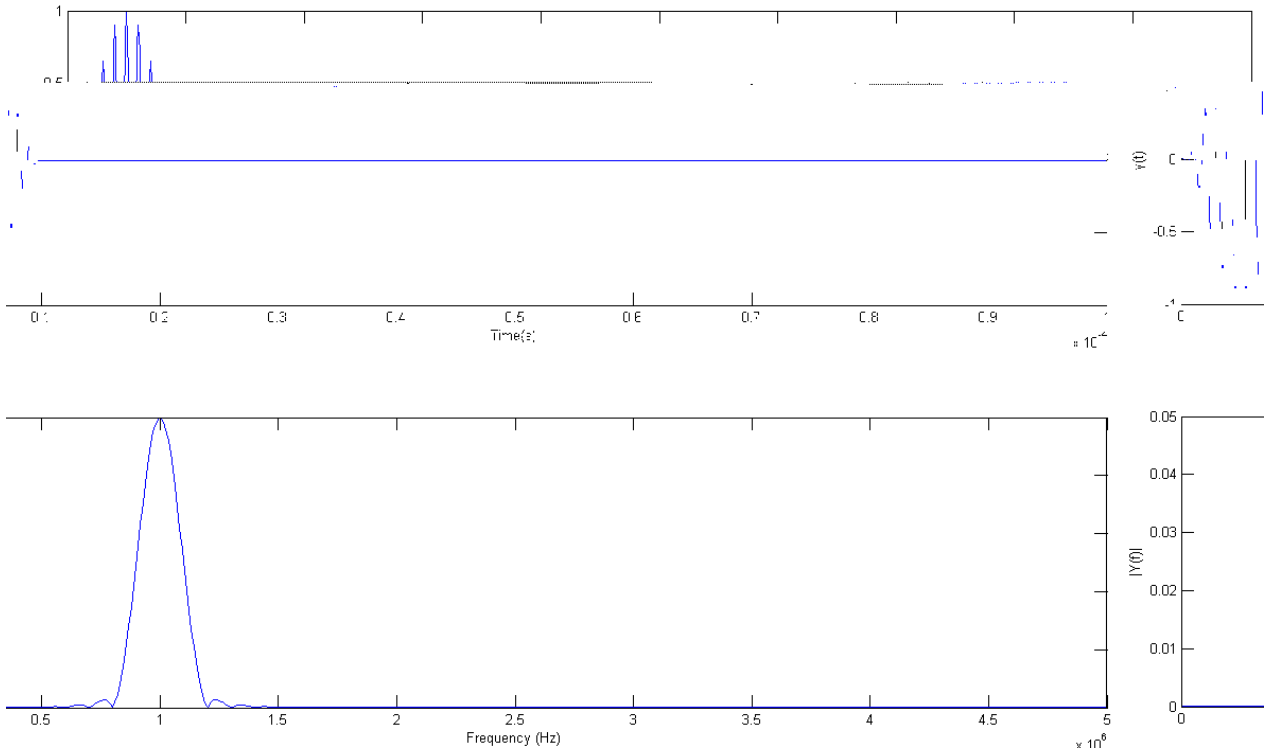


Fig. 8

Concluding remarks

1) A GLARE standard was tested using Pulsed Thermography

2) Two experimental systems were built up for launching and detecting Lamb waves in the GLARE plate.

-Lamb waves launched with a pulsed laser were used to measure the dispersive properties of Lamb waves.

-The experimental measured dispersion curves are co