

Sandia National Laboratories IR Capabilities

**Experimental Mechanics/NDE & Model
Validation - Non Destructive Test Laboratory
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Outline

- Infrared Basics
- New Equipment Purchases
- Thermal Wave Inspection Set-up and Applications
- Infrared Capabilities and Limitations
- Conclusions

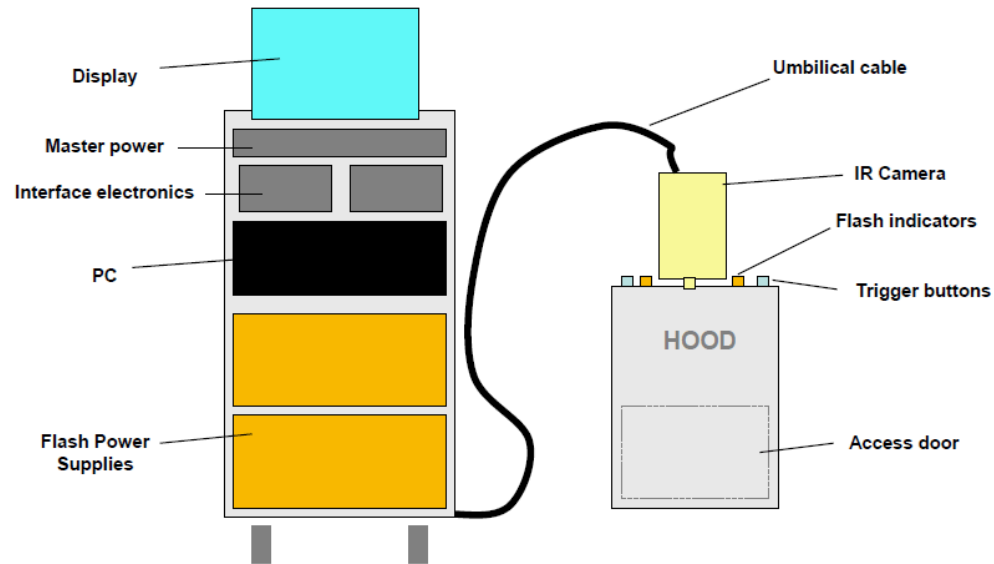


Infrared Basics

- Active Thermography (AT) is defined as a technique where a stimulus is applied to a target to cause the target to heat or cool in such a way as to allow characteristics of the target to be observed by infrared imaging.
- The difference between active from passive thermography is the intentional application of heating, cooling or other excitation method that results in a temperature rise or fall in a target, as compared to an otherwise in situ (passive) target.
- In active thermography, the thermal response of a target to a heating (or cooling) event is analyzed to determine the subsurface structure or material properties of the target. **The time at which temperature changes take place is often more important than the amplitude of the temperature change.**

EchoTherm Equipment

- EchoTherm Software processes thermographic signal reconstruction (TRS) and temperature-time profiles.
- Mosaik software converts live images into data files single or multiple images.
- The hood contains two xenon flash lamps, parabolic reflectors and uses 5000 Joules per lamp.
- FLIR 6106 camera (120 Hz @ 640 X 512 or 420 Hz @ 320 X 256 InSb) detector with 14 bit output.



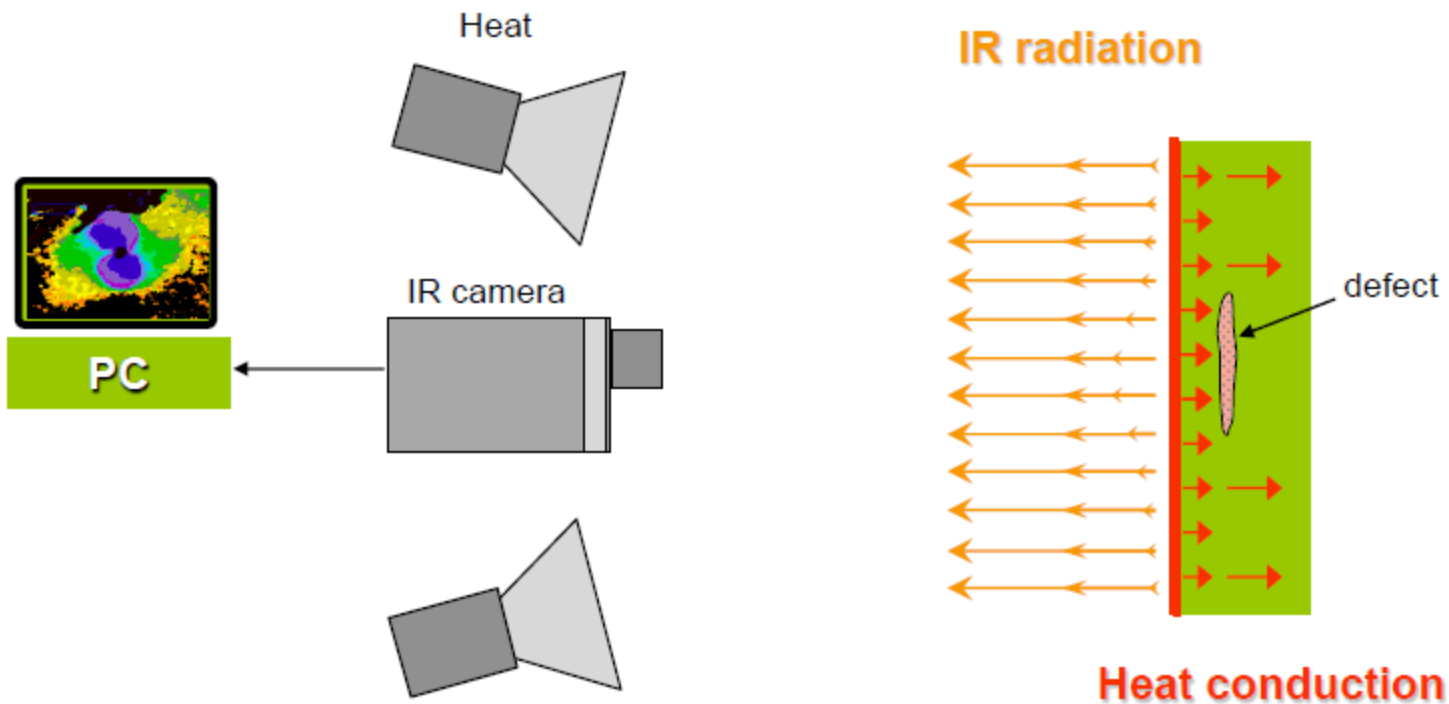
Source: <http://www.thermalwave.com>

VoyageIR Equipment

- EchoTherm (TSR) and MOSAIQ software on a Toughbook laptop (Intel 2.26 GHz processor).
- The IR camera is a Microbolometer - 30 Hz @ 320 X 256 14 bit USB.
- Heat gun with trigger control.
- Handheld color touchscreen (live or saved images available).



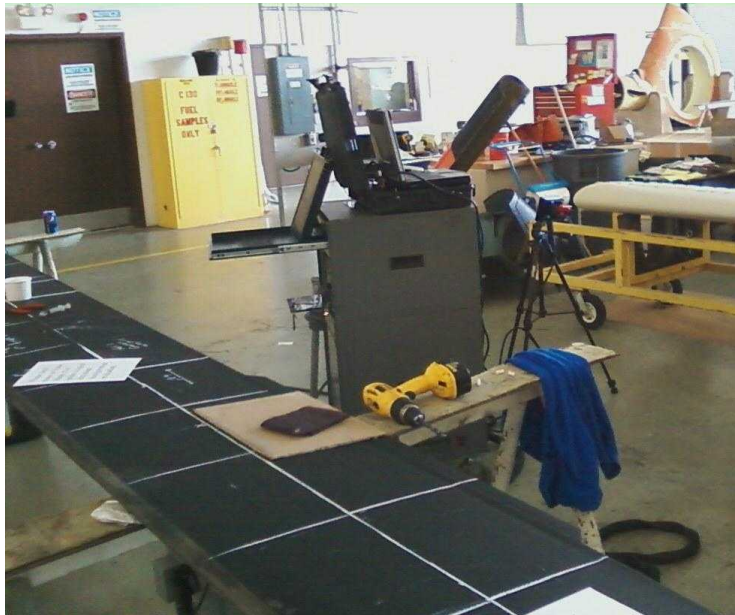
Equipment Set-up



Source: <http://www.thermalwave.com>

Inspection Set-up and Applications

Most composite parts are very large. Need to address fixtures and part movement. These techniques is being developed for water ingress into composite helicopter blades.

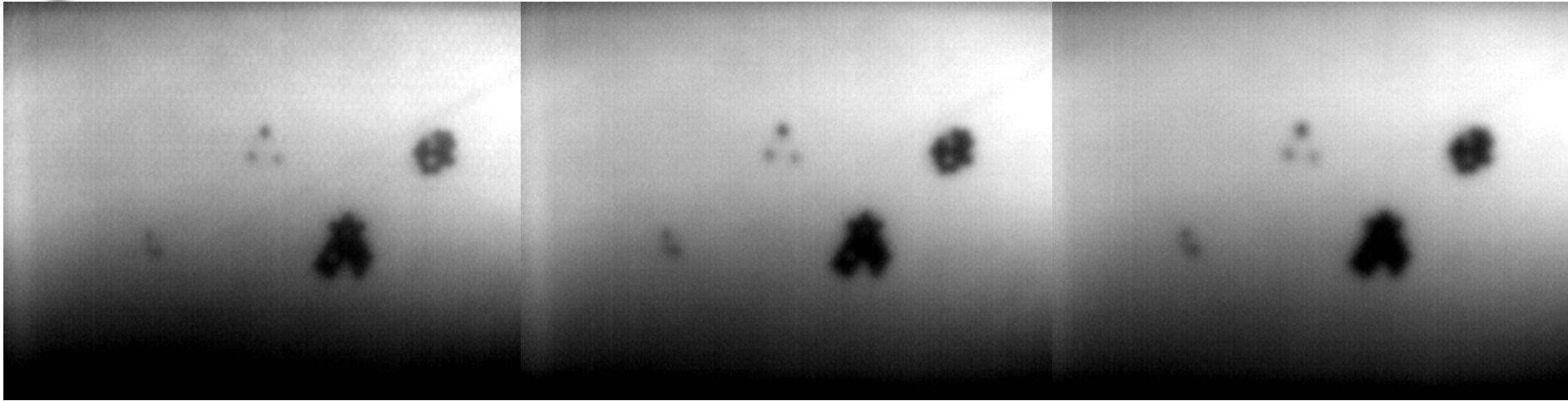


H60 blades in shipping containers

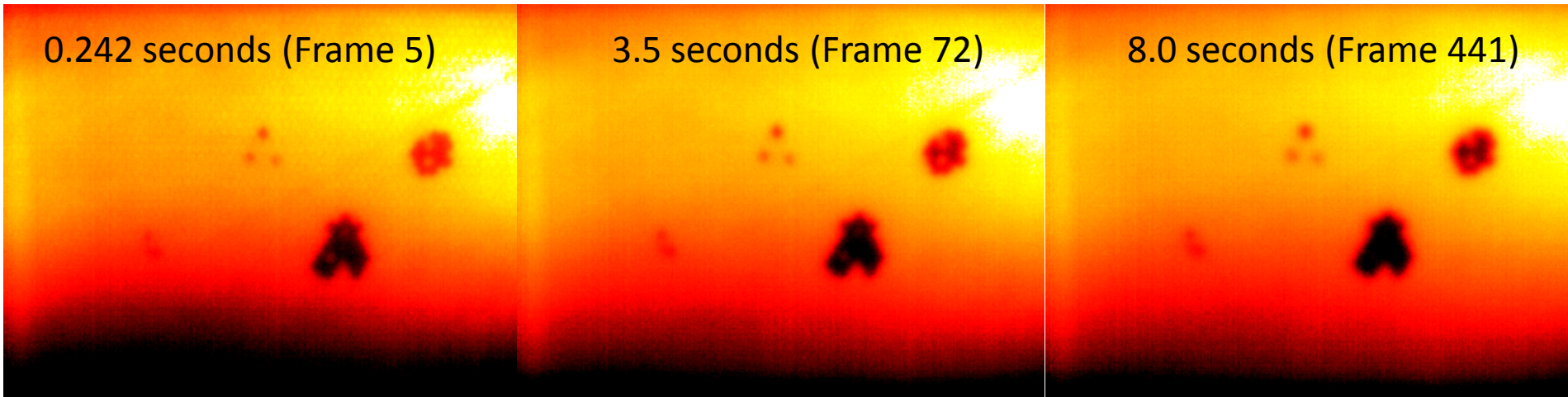


Applying heat

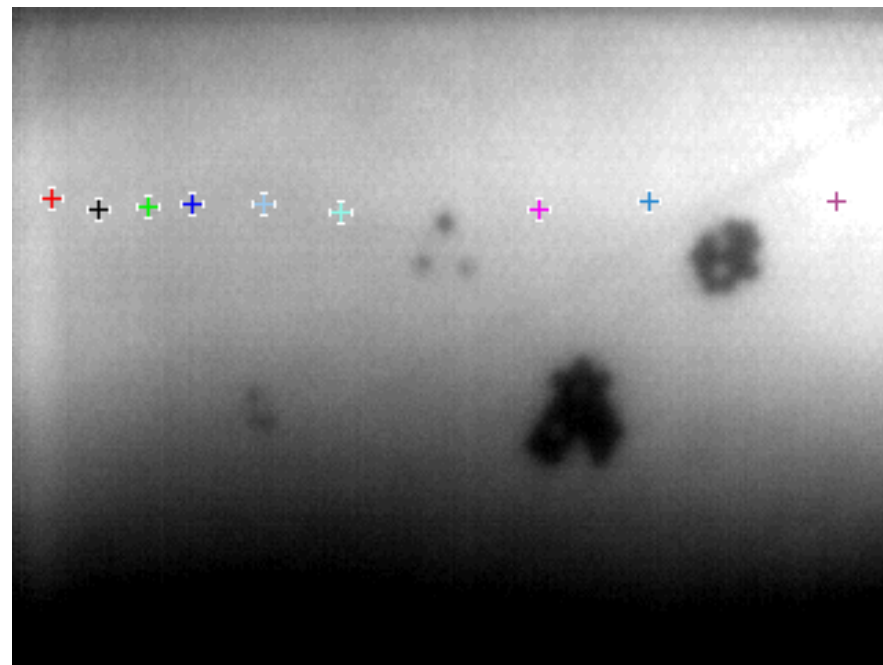
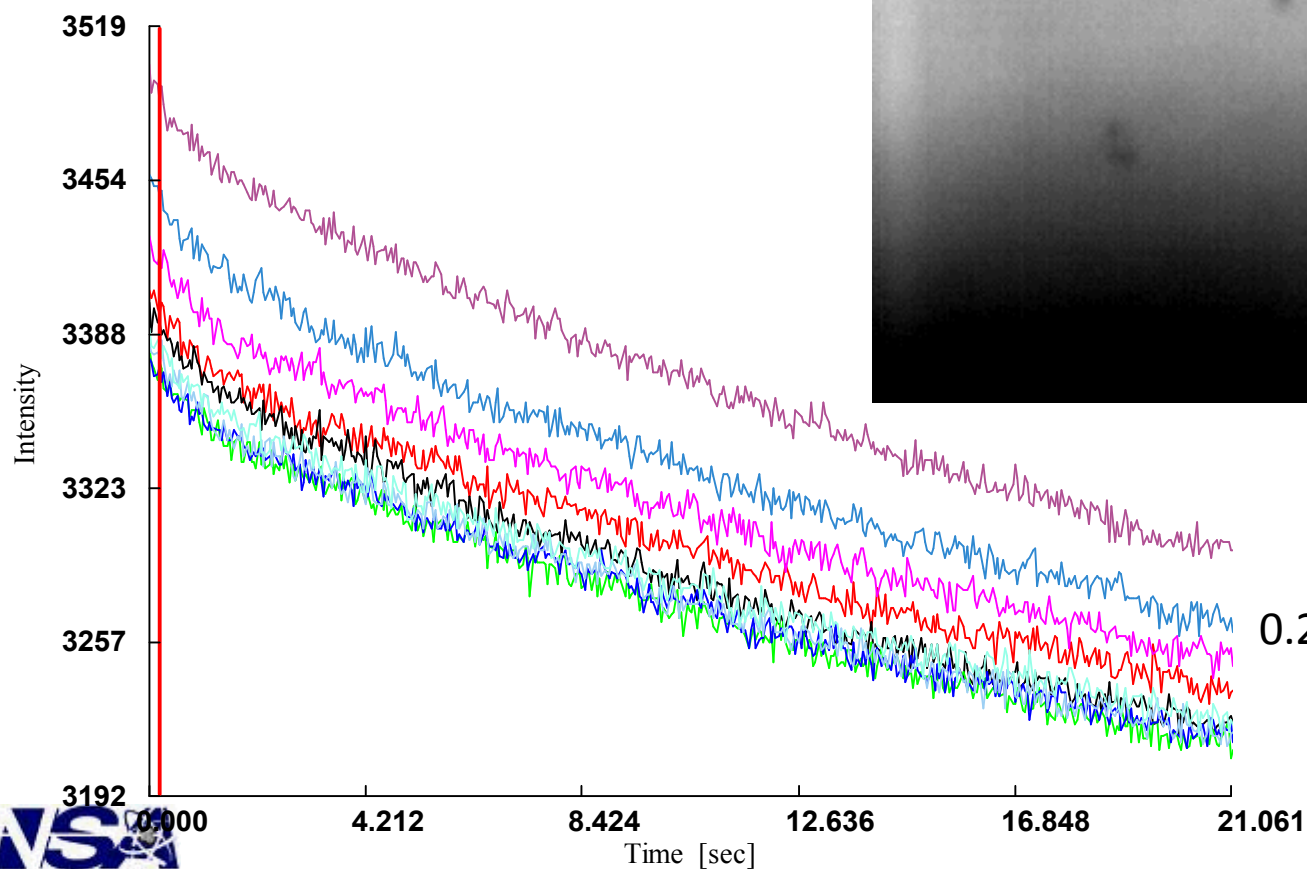
Reviewing IR Data



Water ingress into composite blade



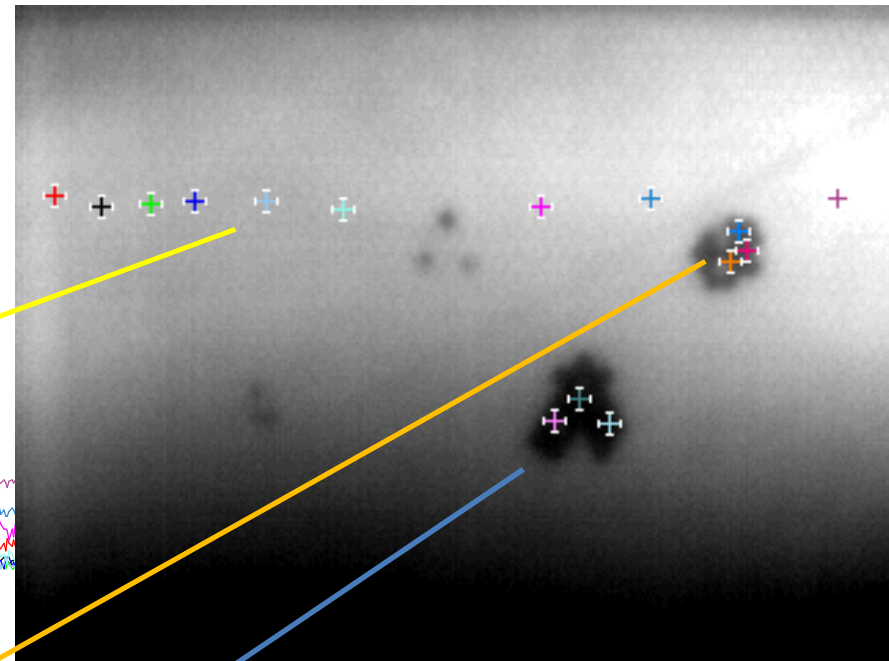
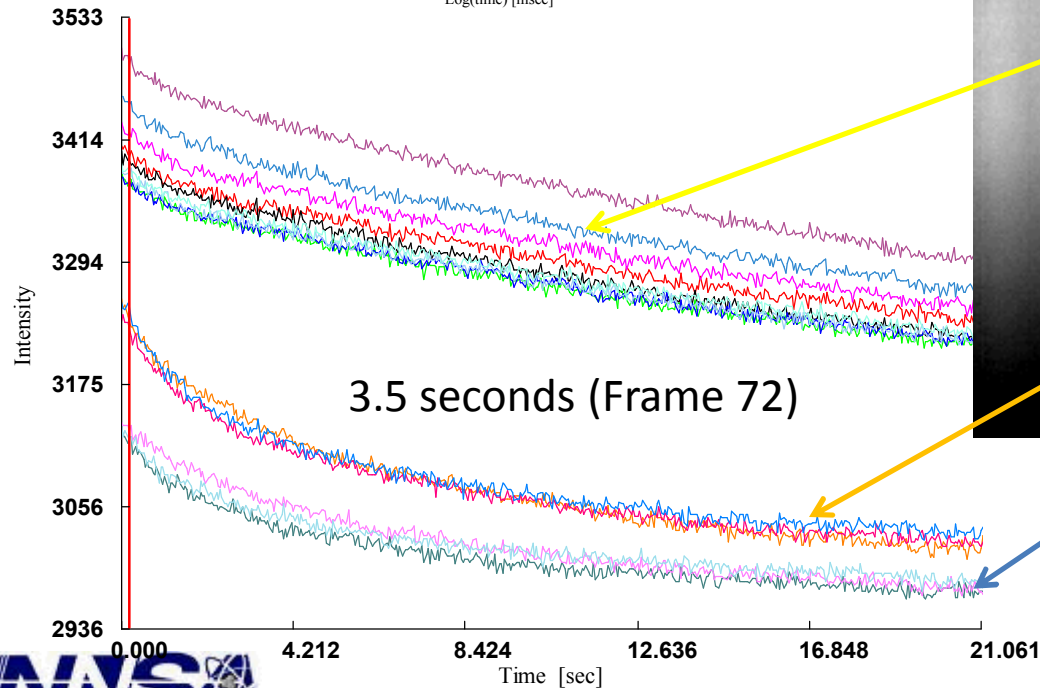
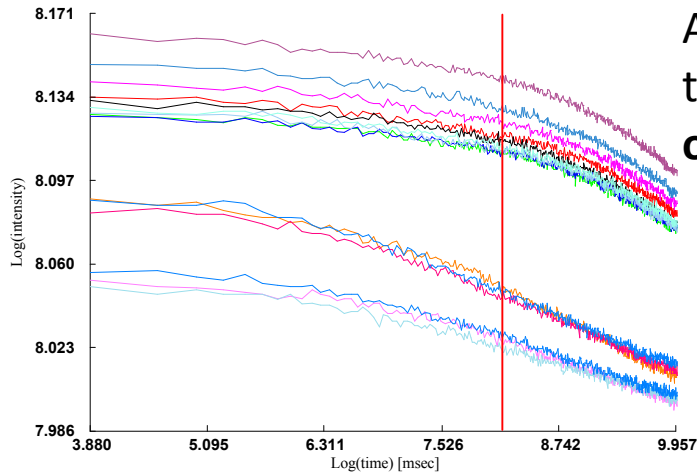
Intensity Time Plot



0.242 seconds (Frame 5)

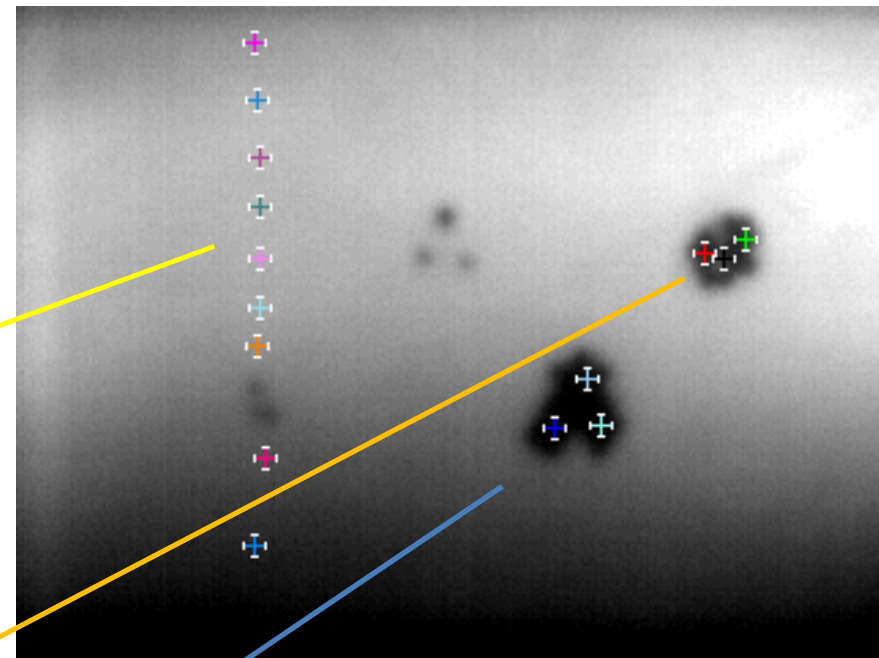
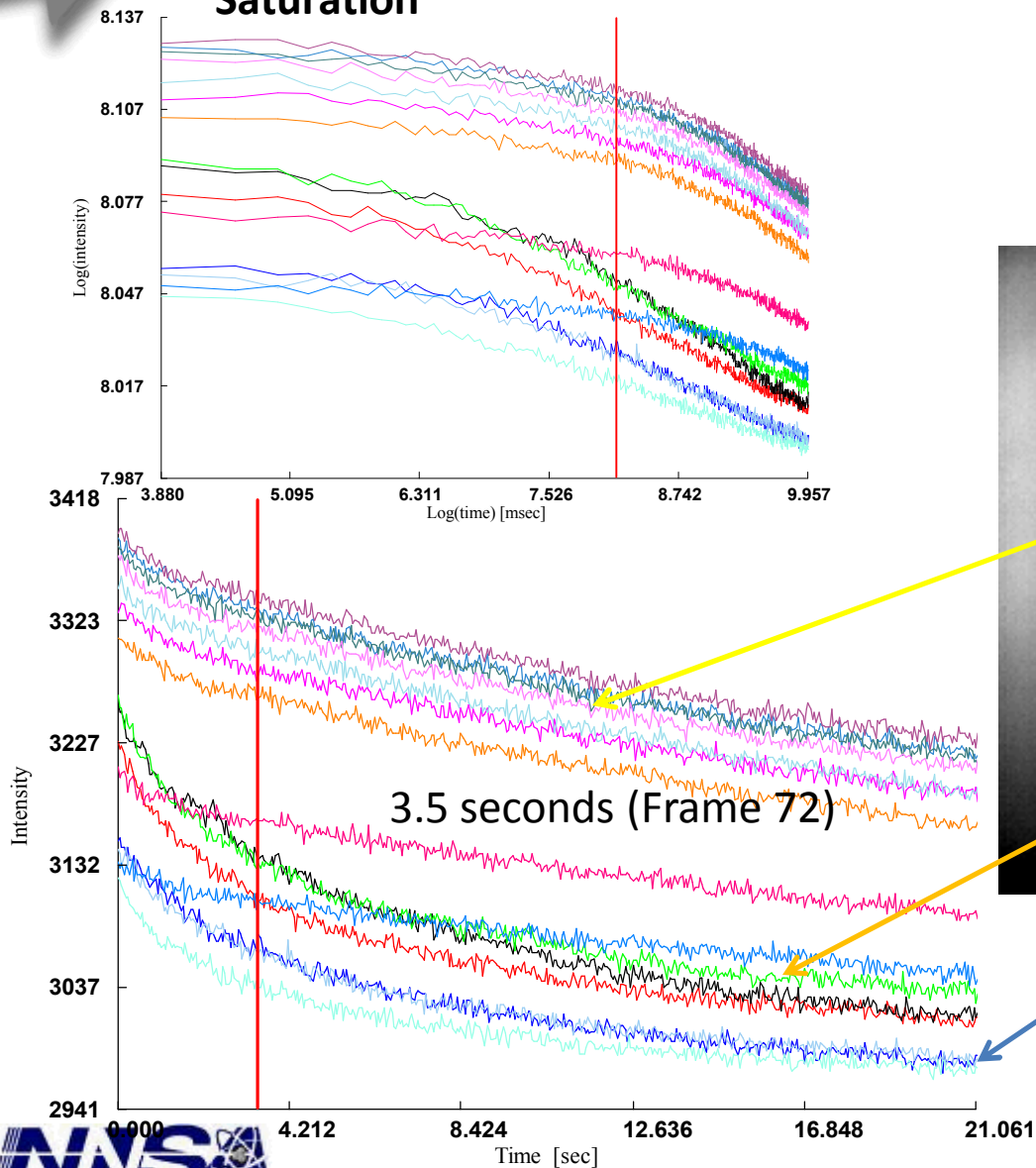
Intensity Time Plot With Defects

Saturation



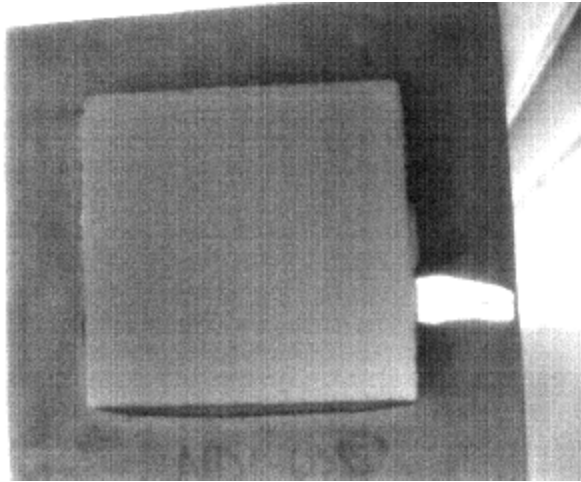
Intensity Time Plot (cont)

Saturation

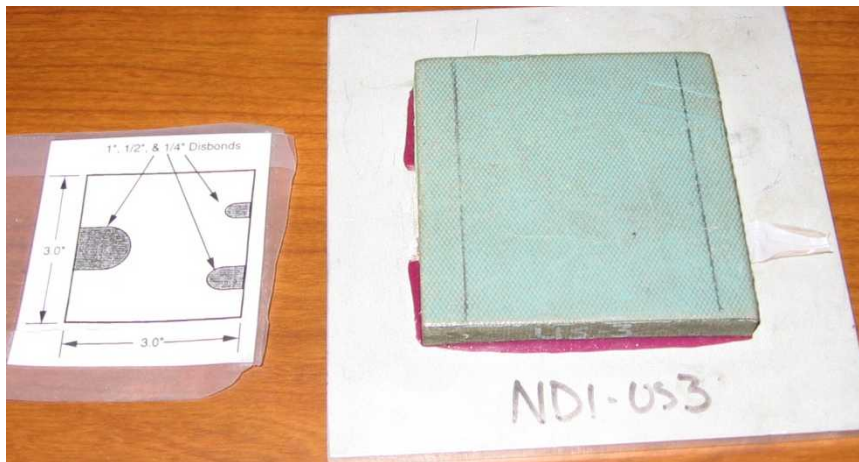
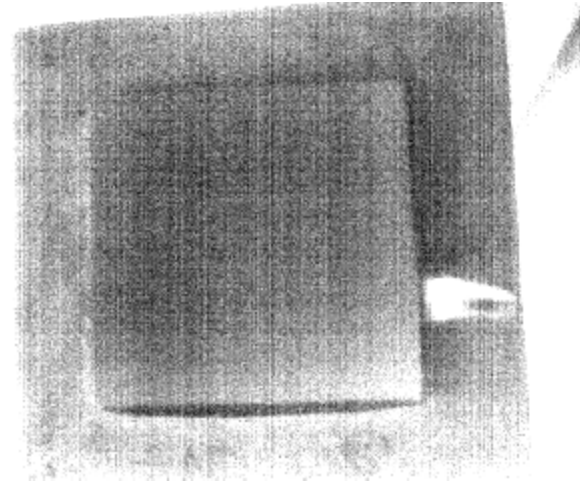


Uneven heating

Thick Composite with Pull Tab



Pull tab

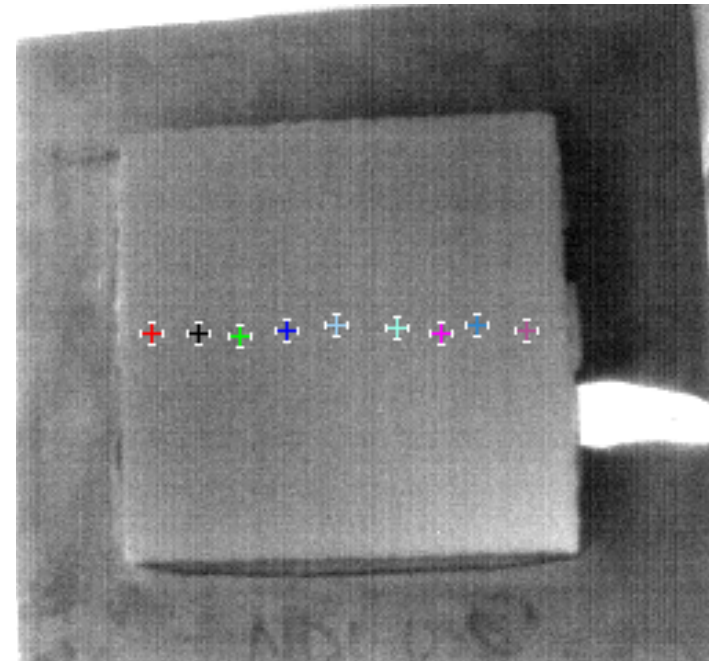
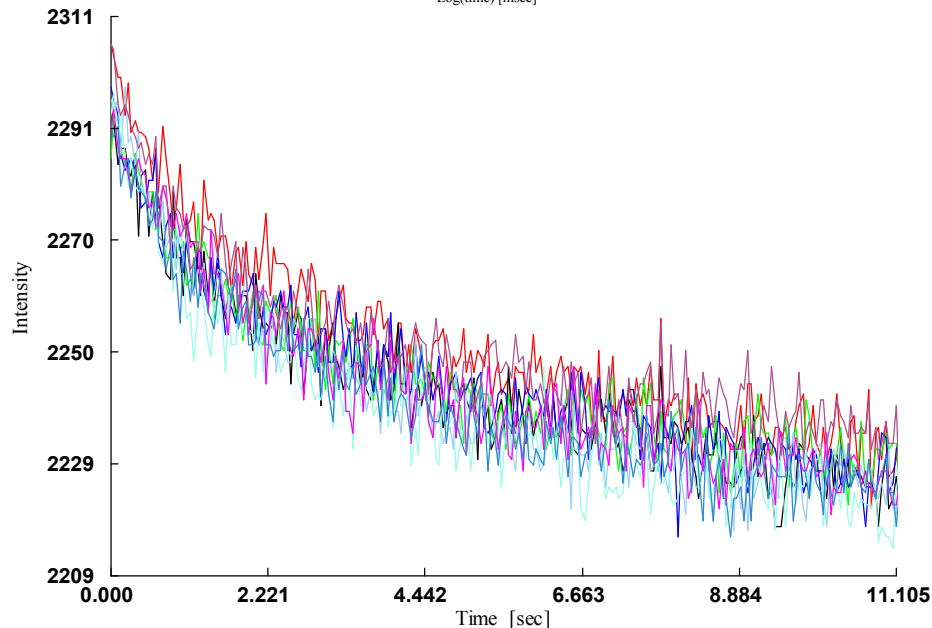
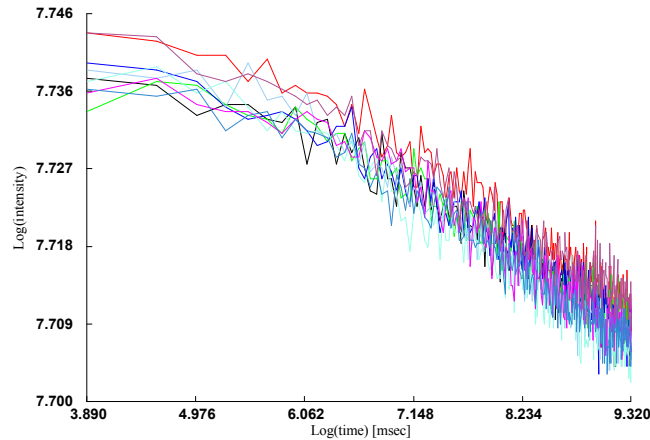


Thick composite bonded onto aluminum plate

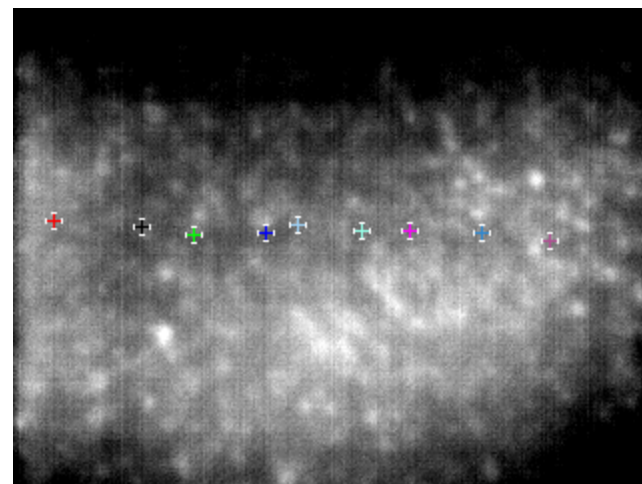
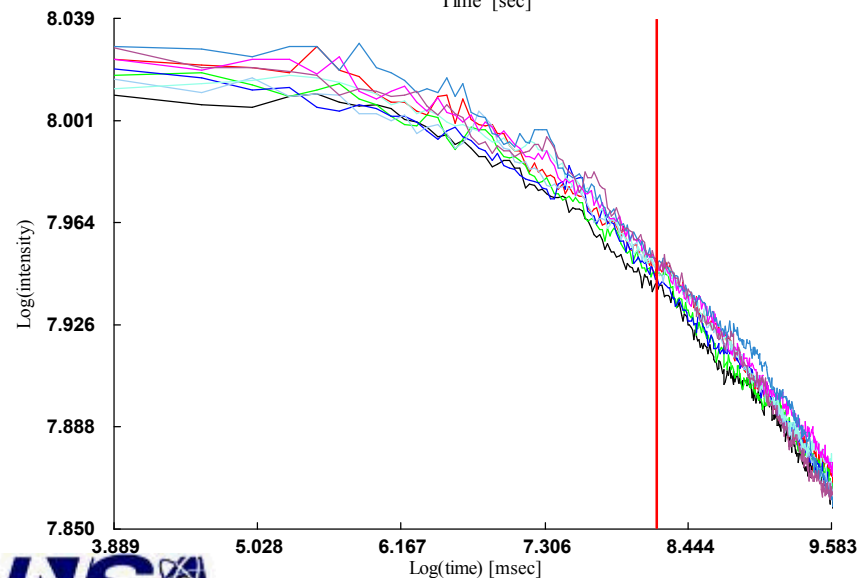
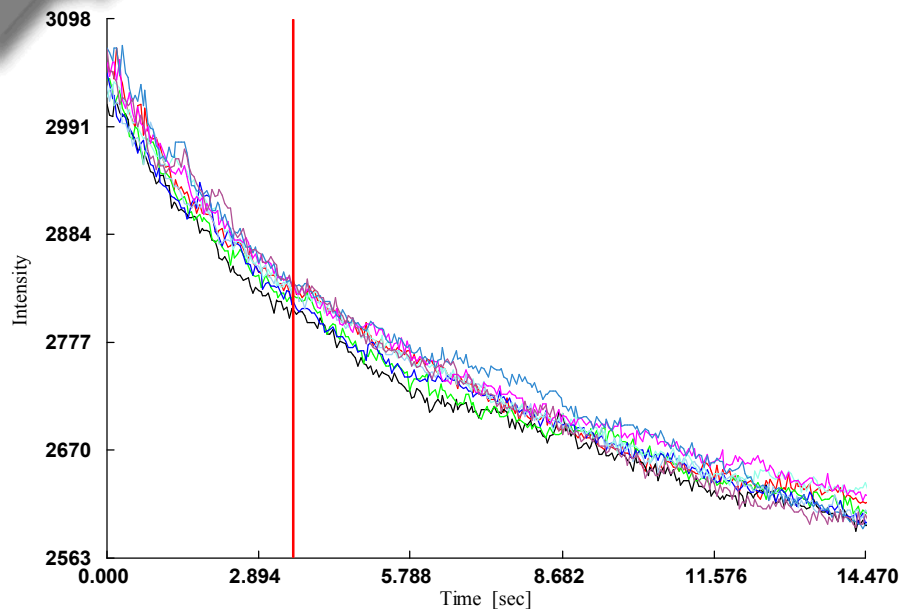


Intensity Time Plot With Defects

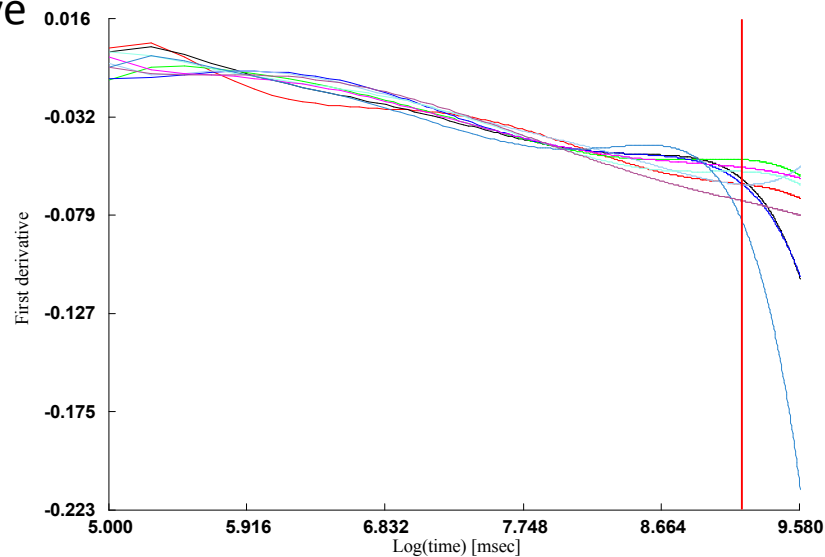
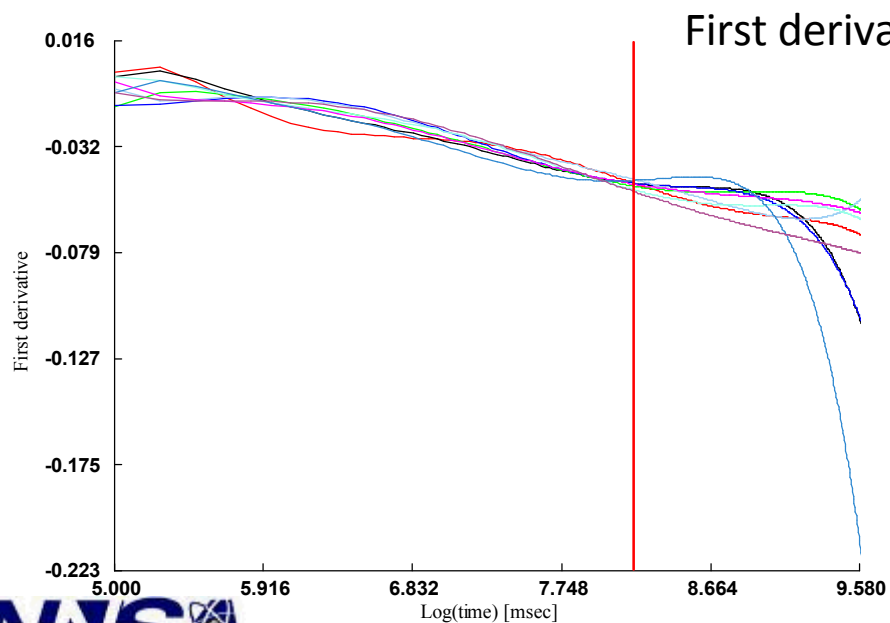
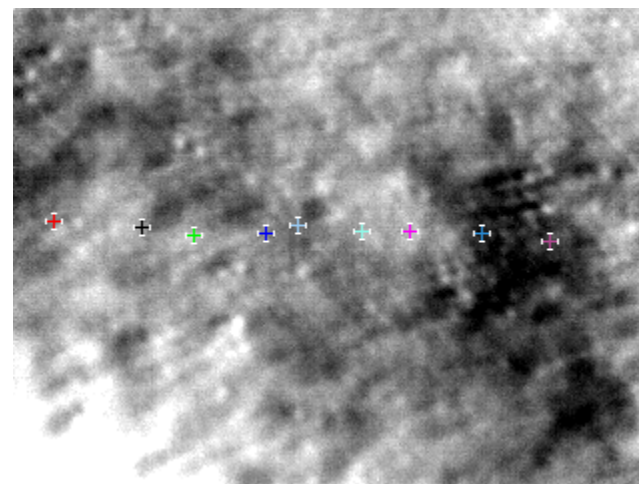
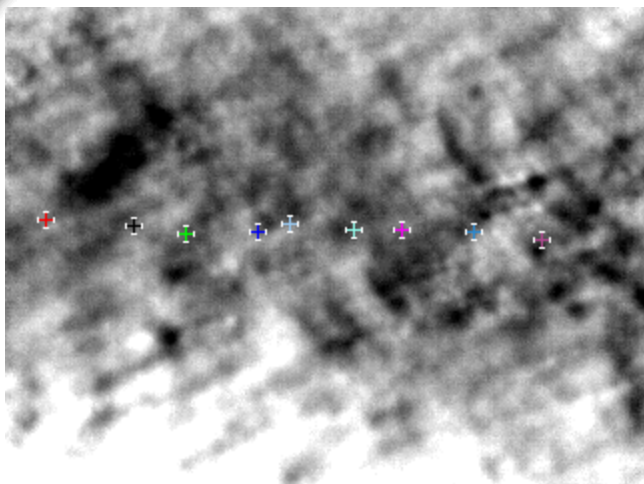
Thick composite creates thermal absorption and scattering with every ply change



Thick Wind Turbine Spar



Thick Wind Turbine Spar (cont.)





Infrared Capabilities and Limitations

- If the surface is shiny then light will be reflected from it. This may not allow enough heat to be deposited into the sample (low signal). A coating of low reflective paint (black) is required.
- Painted surfaces can be deceptive. The surface may be shiny however, the IR emissivity and optical absorption may be enough to produce data. A test with/without paint may be required. In many cases the derivatives remove reflection artifacts that appear in the raw image.
- Most composites appear shiny but can be imaged without painting. The slope processing features extract most required data.
- Many samples generate a reflection of the detector in the image. This effect can be removed in the TSR process or by subtraction of pre-flash images.
- If the log plot of a defect free point is extremely distorted then reflected radiation is the predominate signal and not conductive cooling.



Conclusions

- Infrared technology will enhance Sandia's Nondestructive Inspection Laboratory diagnostic capabilities for future production needs.
- As new products mature IR inspection will be implemented (as required) to assist component engineers.