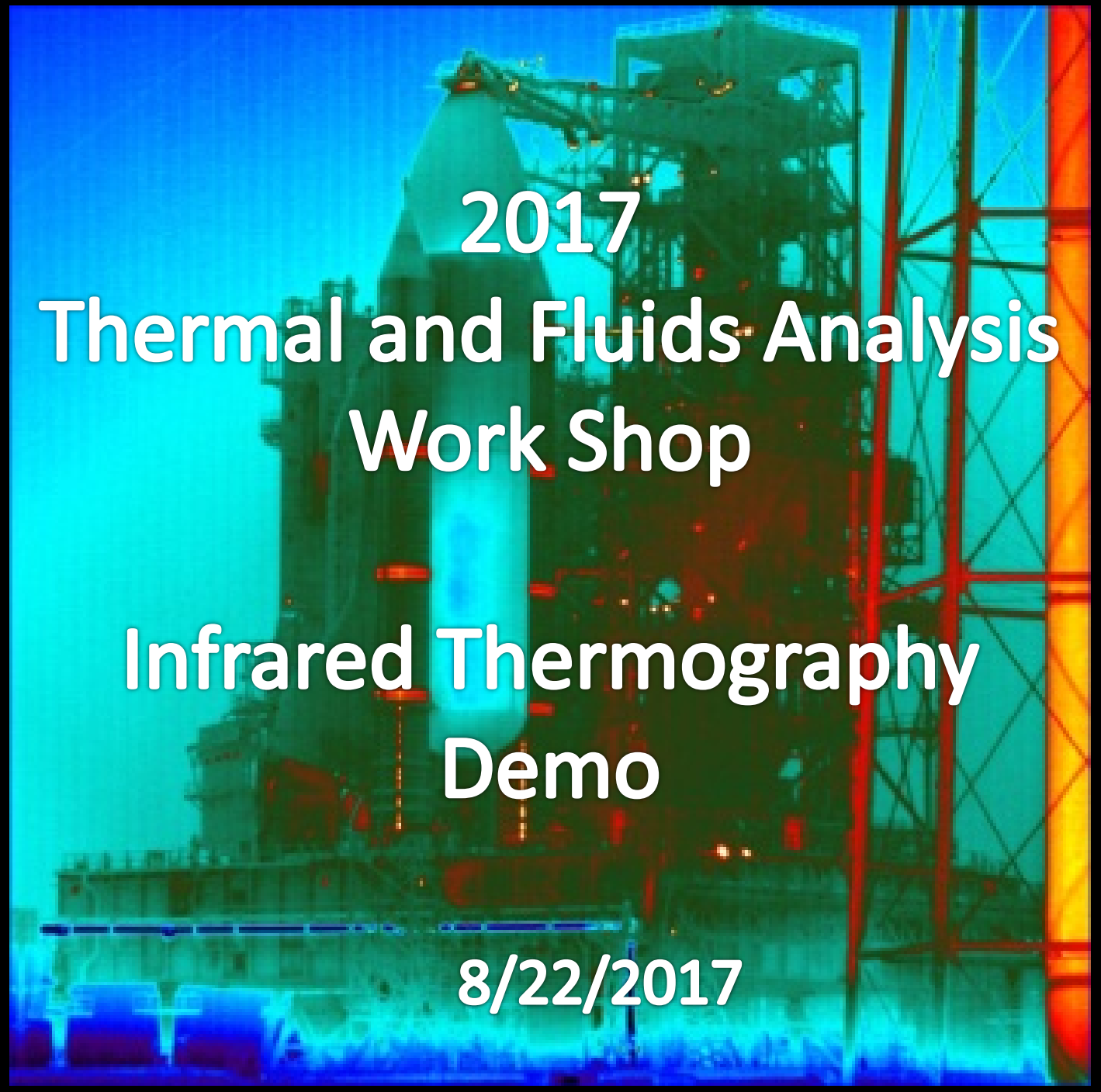


2017
Thermal and Fluids Analysis Work Shop

Infrared Thermography Demo

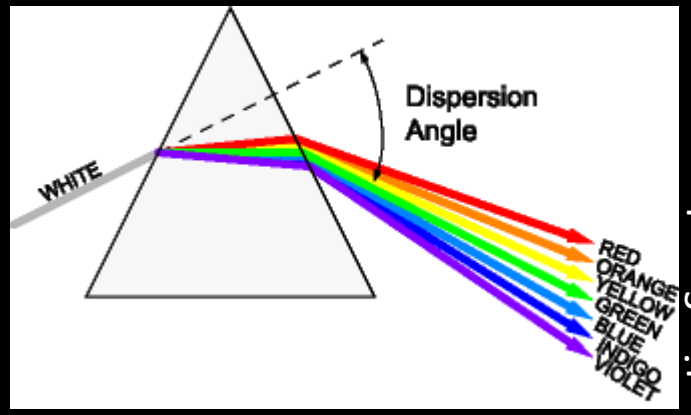
8/22/2017

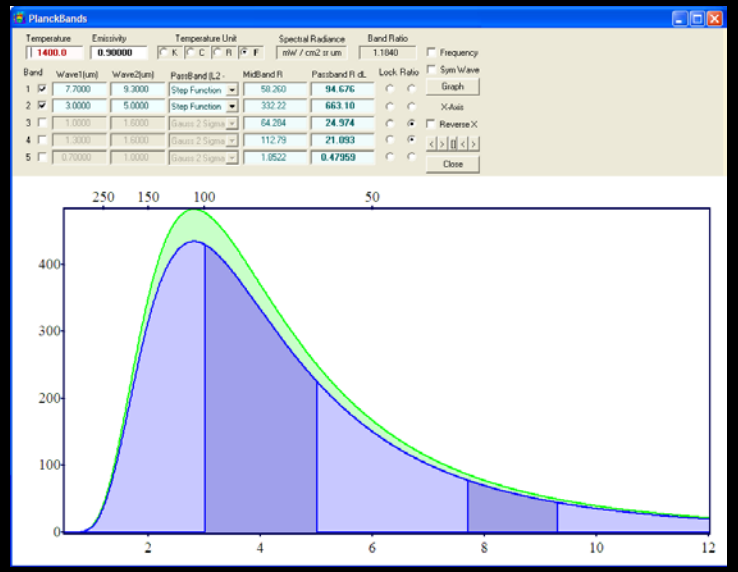
Infrared Thermography
TWAWS Demo

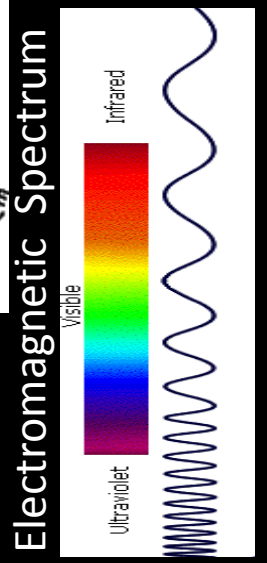
- Definition of Infrared Thermography
- Herschel Discovers Infrared
- Thermal Imaging vs. Infrared Thermography
- Emissivity
- Infrared Calibration facility
- MSFC Infrared deployment
- MSFC Software Development
- MSFC Infrared examples

Infrared Thermography

- Infrared thermography, thermal imaging, thermographic imaging, or thermal video, is a type of infrared imaging science.
- Thermographic cameras detect radiation in the infrared range of the electromagnetic spectrum (roughly 900-14,000 nanometers or 0.9–14 µm) and produce images of that radiation, called thermograms. Since infrared radiation is emitted by all objects near room temperature, according to the black body radiation law, thermography makes it possible to "see" one's environment with or without visible illumination.
- The amount of radiation emitted by an object increases with temperature, therefore thermography allows one to see variations in temperature (hence the name).
- When viewed by thermographic camera, warm objects stand out well against cooler backgrounds; humans and other warm-blooded animals become easily visible against the environment, day or night.
- As a result, thermography's extensive use can historically be ascribed to the military and security services.







Herschel Discovers Infrared

https://www.youtube.com/watch?v=_L7UlqIdGuQ

Infrared Thermography

Is there is a difference between Thermal Imaging and Infrared Thermography?

YES!

- Thermal Imaging is a visual image representing the energy detected in the infrared portion of the electromagnetic spectrum.

- Infrared Thermography is science of acquisition and analysis of thermal information from non-contact thermal imaging devices , including thermal imaging cameras.

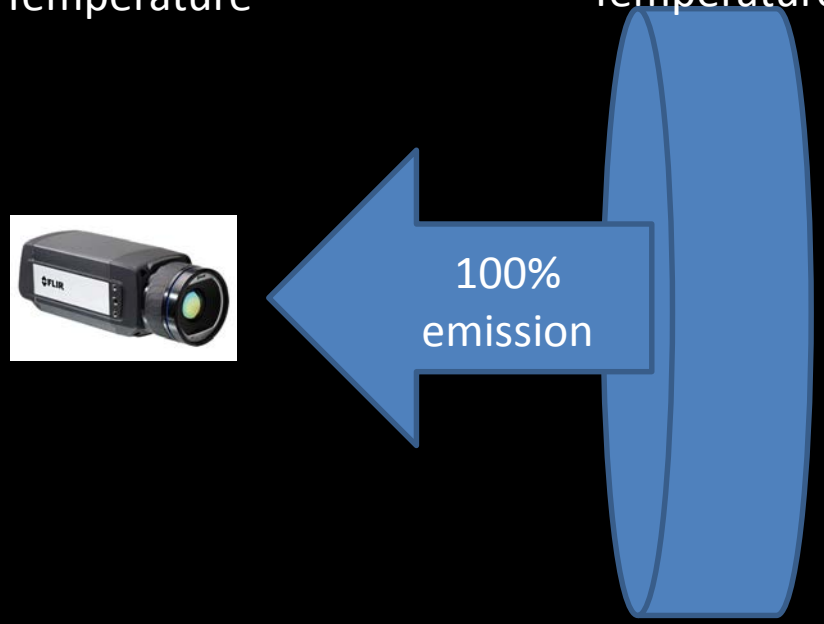
  - knowledge and experience to correctly setup the thermal imaging camera systems including the understanding of a body's "emittance" of radiation
  - remotely operate and record the data
  - post process the data into usable engineering deliverables
  - interpret the infrared data with analytical thermal mathematical tools.
    - ER43 excels in the processing of infrared measurements converted into time vs. temperature. Used in correlating thermal math models which are used to predict design loads or off nominal loads.
    - Note: ER43 Does not Perform Non Destructive Evaluation (NDE) Infrared Thermography. Contact Sam Russell or James Walker for Flash Thermography

Emissivity

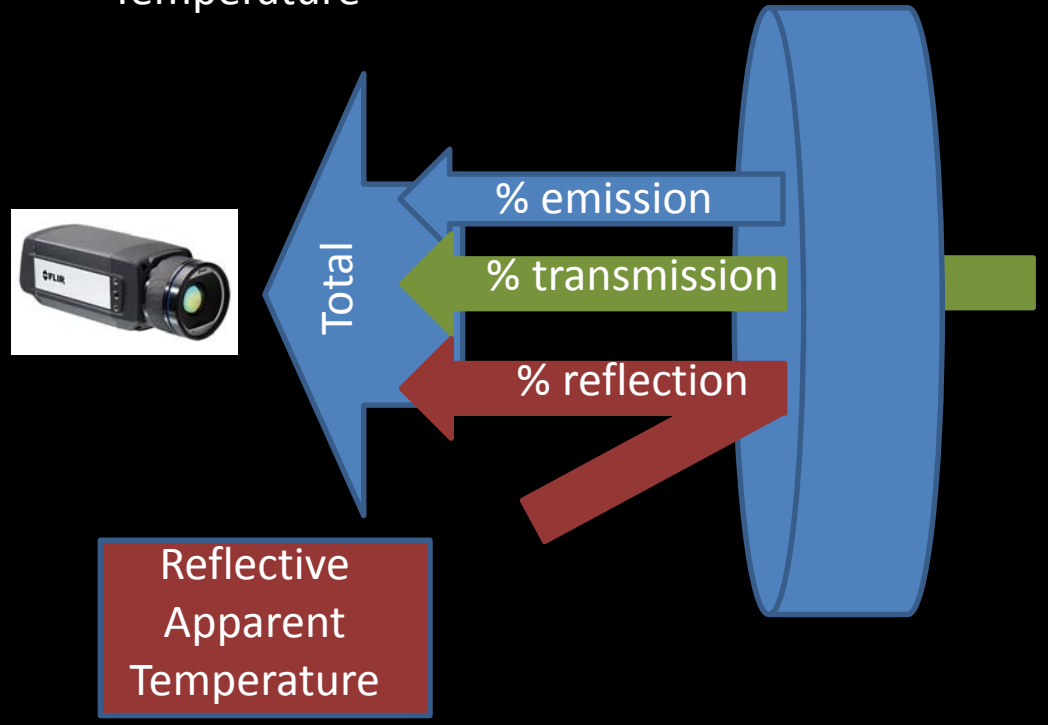
Effects on Infrared Thermography

Perfect World

Apparent Temperature = Actual Temperature



Apparent Temperature ≠ Actual Temperature



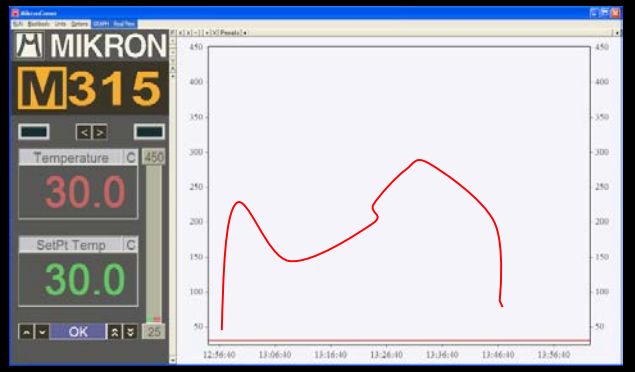
$\varepsilon = 1.0$

$\varepsilon < 1.0$

Facilities - Infrared Calibration Facility – Bldg 4205

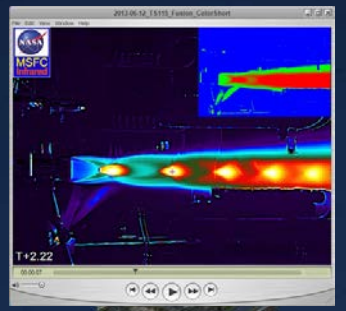
Cavity and Wide Area Blackbodies

- Custom Calibration to specific applications
- Custom software will allow automated calibrations
- Large environmental enclosure to allow hot/cold housing calibrations
- Facility available to others (e.g. provide calibration for KSC Infrared Cameras)
- Provide a calibrated reference temperature to calibrate thermal imaging cameras and non–uniformity correction
    - MIKRON M315 -20°C to 150°C
    - MIKRON M340 -5°C to 350°C
    - MIKRON M330 300°C to 1700°C
    - MIKRON M390S 600°C to 3000°C
    - Santa Barbara Infrared 4006 50°C to 600°C

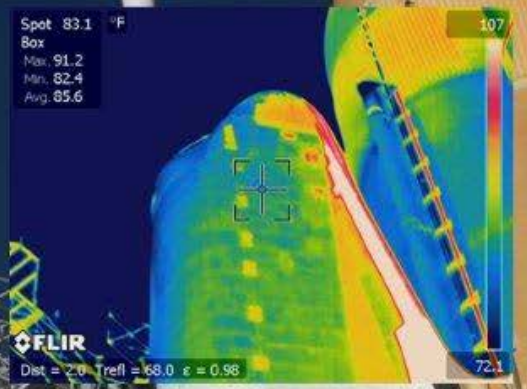


NASA MSFC Infrared Thermography

Peregrine Solid Rocket Motor



Infrared Fusion System



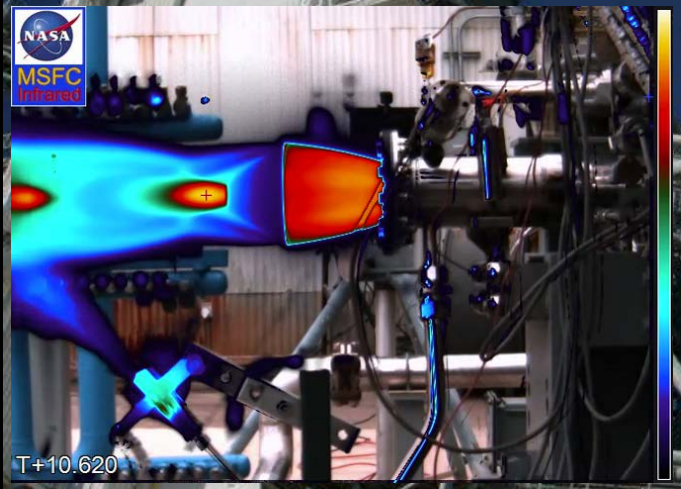
Shuttle Lift -Off Debris Detection
Multi-Spectral Experiment
With AMES and KSC

Scale Model Acoustic Test

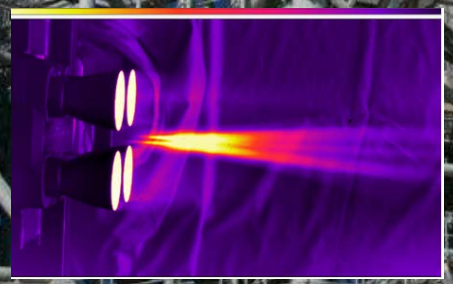
NASA MSFC Team specialized with High Temperature Calibrated Infrared Thermography
Infrared Thermography Systems –
- Cameras
- Pyrometers
- infrared Calibration Facility – Bldg 4205
- Software development / data reduction

People -
- Infrared Thermographer Certification
- MSFC Thermography Team Personnel

STS-135 Shuttle Landing



SLS EUS Nozzle Extension



SLE EUS
CUBRC Buffalo, NY

Contact -
Darrell Gaddy
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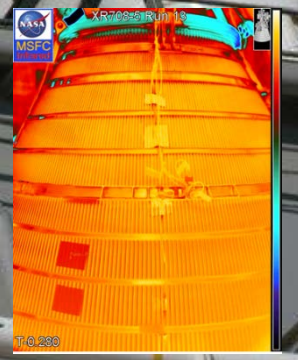
Darrell.E.Gaddy@nasa.gov



SLS EUS RL-10
AJR West Palm Beach, FL

SLS Launch Abort System
Solid Rocket Motor
Orbital ATK

STS-135 Ascent Highlights

Shuttle STS-135 Ascent Highlights

www.youtube.com/watch?v=rVJDYI1BQA4

From IR to Analysis

- The IR capability was developed as a grass roots effort to provide surface temperatures into Thermal Math Models where contact temperature measurement is impractical.
- The Infrared Thermography is optimized with thermal analysis engineers knowing the desired delivery products for use as boundary conditions into thermal math models.
- Factors which account for the apparent temperature , background