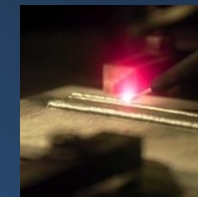
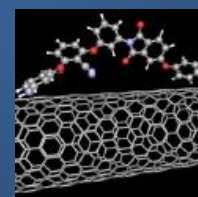
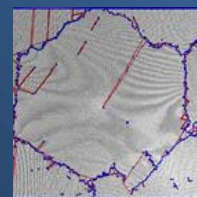
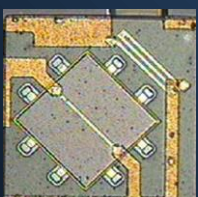
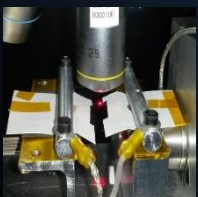
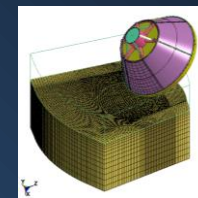
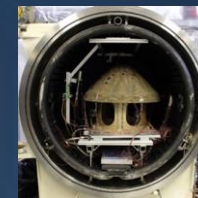
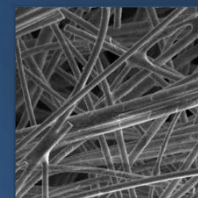
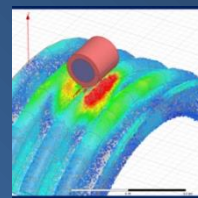
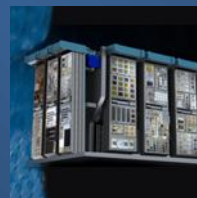
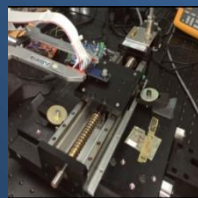
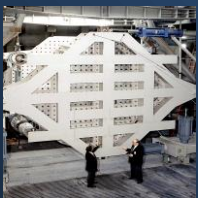
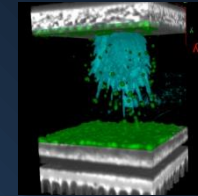
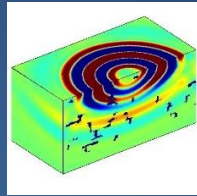
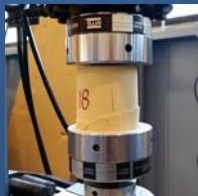
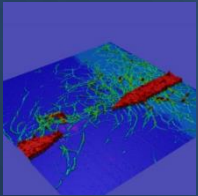
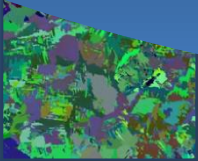




NASA Langley Research Center Structures & Materials Capabilities

Elliott Cramer
Associate Director





Research Directorate - Organization Leaders & SMEs

LaRC – Research Directorate

W. Allen Kilgore, Director
Jill Prince, Deputy Director

David Shinn, Associate Director for Facilities & Labs
Joseph Paterson, Sr. Safety Engineer
Michael Madden, Chief Engineer for Modeling & Simulation
Eric Walker, Chief Engineer for Test Operations
Vacant, Chief Engineer for Measurement Systems
Tony Washburn, Chief Technologist
Vacant, Chief Operations Officer

Aerosciences

John (JD) Reeves, Deputy Director
Robert Scott, Associate Director
Steve Bauer, Chief Engineer

Configuration Aerodynamics
Sally Viken, Head

Computational Aerosciences
Beth Lee-Rausch, Head
Mujeeb Malik, Aerodynamics ST

Flow Physics & Control
Catherine McGinley, Head

Advanced Measurements & Data Sys.
Thomas Jones, Head
Paul Danehy, Adv. Measurements ST

Aerothermodynamics
Kelly Murphy, Head
Bil Kleb, Aerothermodyn. ST

Hypersonic Airbreathing Propulsion
Richard Gaffney, Head

Aeroelasticity
Russ Rausch, Head

Aeroacoustics
Michael Doty, Head
Steve Rizzi, Aeroacoustics ST

Structural Acoustics
Randolph Cabell, Head

Subsonic/Transonic Testing
Roman Paryz, Head

Supersonic/Hypersonic Testing
Michael Difulvio, Head

Structures & Materials

Jonathan Ransom, Deputy Director
Elliott Cramer, Associate Director
Ralph Buehrle, Chief Engineer

Advanced Materials & Processing
Catharine Fay, Head
Brian Jensen, Advanced Materials ST

Durability, Damage Tolerance, & Reliability
Stephen Smith, Head
Ed Glaessgen, Computational Materials ST

Structural Mechanics & Concepts
Ted Johnson Head

Nondestructive Evaluation Sciences
Cara Campbell-Leckey, Head

Structural Dynamics
Martin Annett, Head

Materials & Structures Experiments
Kelly Tarkenton, Head

Intelligent Flight Systems

George Finelli, Deputy Director
Jennifer Kibler, Associate Director
Mike Fremaux, Chief Engineer

Dynamic Systems & Control
Will Johnson, Head
Irene Gregory, Advanced Controls ST

Flight Dynamics
Corey Diebler, Head

Crew Systems & Aviation Ops.
Keith Arthur, Head
Danette Allen, Intelligent Flight Systems ST

Electromagnetics & Sensors
Gary Kellogg, Head

Safety-Critical Avionics Sys.
Eric Cooper, Head

Revolutionary Aviation Technologies
Jay Ely, Head

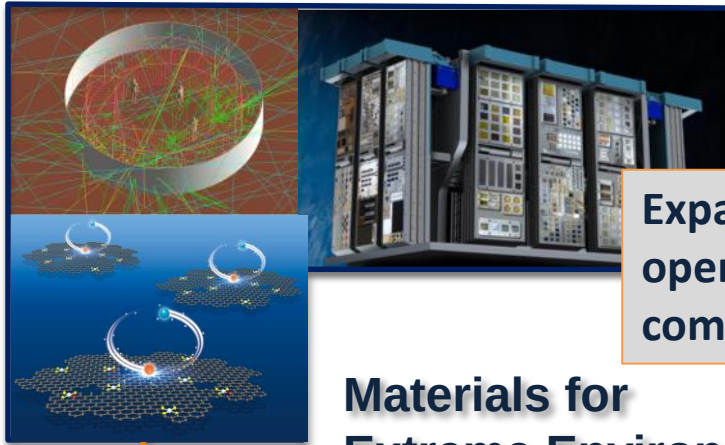
Autonomous Integrated Systems Research
Gary Kellogg, Head



Advanced Materials and Processing

Making the materials of tomorrow, today

LaRC – Research Directorate



**Materials for
Extreme Environments**

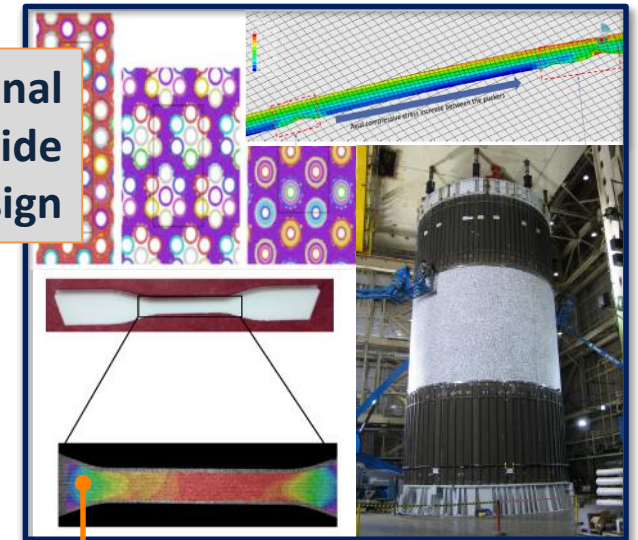
Expanding the range of
operational environments of
component technology

Developing and demonstrating
advanced fabrication technology

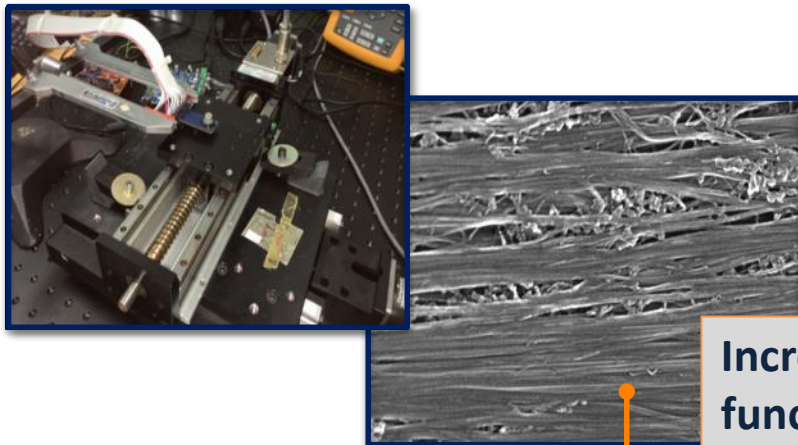


Process Development

Developing validated computational
models and simulations to guide
materials design



Modeling and Simulation



Characterization

Increasing performance and
functionality of load bearing
structures



Advanced Materials and Processing Facilities & Competencies

LaRC – Research Directorate

- **Materials Synthesis**

- Chemical (small molecule)
- Polymer (macromolecule)

- **Materials Processing**

- Prepreg and Composite (any resin/fiber)
- Solution film casting/melt extrusion
- Vac Press, VARTM, Autoclave, ATP
- Plasma Spray
- EBF3
- SLM
- Bonding/Joining
- Heat treatment Vac. Furnaces
- Sputtering/PVD
- Advanced Metal Forming

- **Mechanical**

- Electromagnetic/servo-hydraulic load-frames (Liq. He to 3000F to 10-7T)
- Small Ball-screw frames w/ E-Chambers
- Pin-on-disk Tribometer w/ furnace
- Tabor Abrader

Core Competencies

- | | |
|--|--|
| <ul style="list-style-type: none">• New Materials Through Synthesis• New Materials Through Processing• Composite Processing Technology• Composite Processing Modeling | <ul style="list-style-type: none">• Composite Bonding Technology• Characterization of Materials• Computational Modeling and Simulation• In-space testing of materials |
|--|--|

- **Analytical**

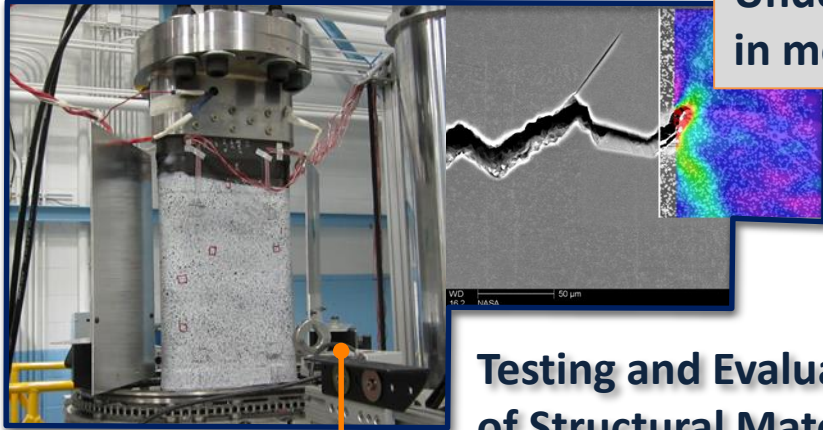
- Microscopy: SEM/TEM/HR-SEM Xe⁺-PFIB: SEMs – Variable Pressure Lg chamber (w/ EDX, WDS, μ -probe, load frame, EBSD/AFM tips, EELS, SIMS)
- Thermal Analysis: DSC, TGA, TGA-MS, DMA, TMA, Laser Flash, Heat Flow, Rheometers
- Spectroscopy: NMR, IR, near-IR, UV-Vis, RAMAN, /XRD, Elipseometer, XPS, Auger
- Chromatography: GPC, GC-MS
- Surface Analysis: Droplet and Insertion instruments for surface tension, Optical profilometer, SPM, Nitrogen Absorption
- Optical Microscopy: Confocal, Fluorescence, Metallograph, X-Polarized



Durability, Damage Tolerance, & Reliability

Understand damage and failure of structural materials

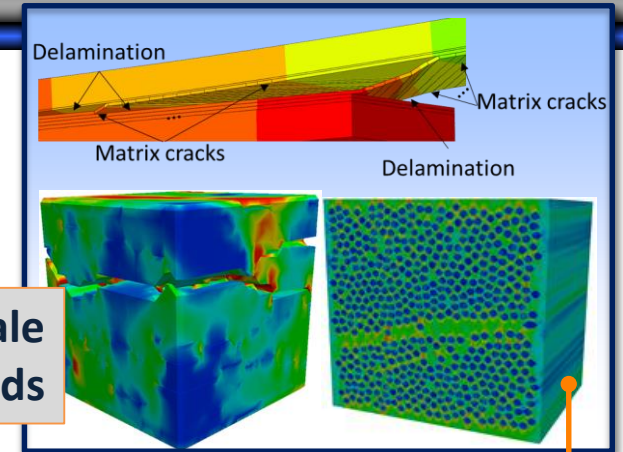
LaRC – Research Directorate



Testing and Evaluation
of Structural Materials

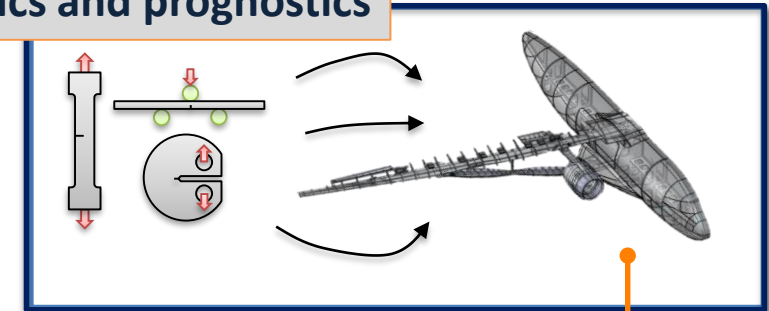
Understanding damage mechanics
in metallic and composite materials

Developing multiscale
computational codes / methods



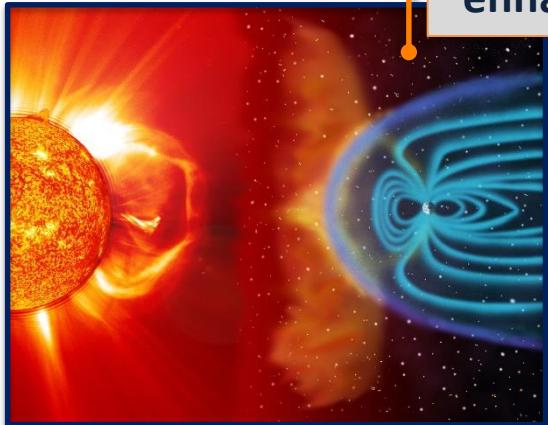
Computational Modeling
of Damage in Materials

Enabling digital twin through advanced
diagnostics and prognostics

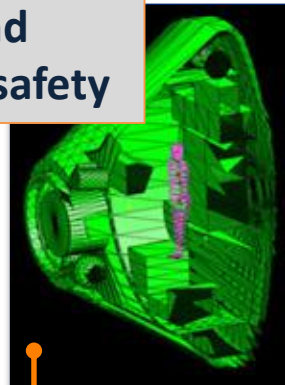


Digital Twin /
Health Assessment

Space Environments



Understanding and
enhancing astronaut safety



Radiation Shielding and
Design



Durability, Damage Tolerance, & Reliability Facilities & Competencies

LaRC – Research Directorate

- **Materials Research Lab**

- ~ 40 uniaxial load frames (up to 400 kip)
- Biaxial load frame
- 3 tension – torsion load frames
- Axial – Tension Bending load frame
- Environmental chambers from -320° F to 1000° F
- Ultrahigh vacuum chamber
- DMA (Dynamic Mechanical Analysis)

- **Digital Image Correlation**

- **Electron Microscopy (PFIB)**

- **Confocal Microscopy- FRASTA**

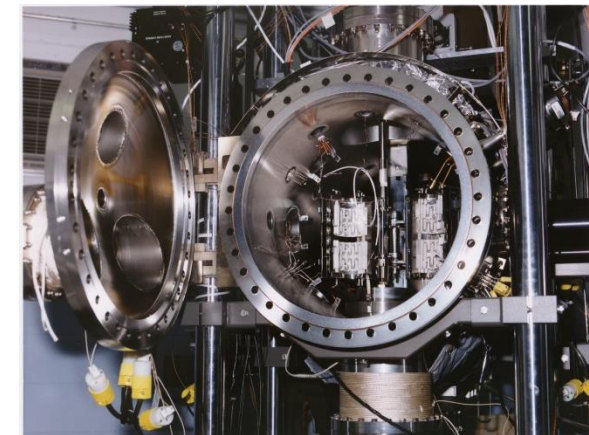
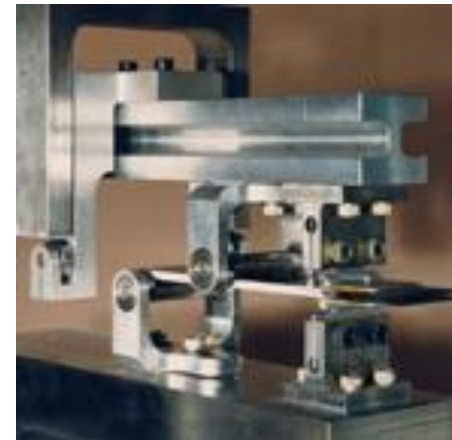
- **In-situ Inspection (UT, X-Ray, thermography)**

- **Materials Processing**

- Arc Melter
- Crystal Puller

Core Competencies

- | | |
|---|----------------------------------|
| • Damage Mechanics of Composite Materials | • Space Environments |
| • Damage Mechanics of Metallic Materials | • Radiation Shielding and Design |
| • Digital Twin | |





Structural Mechanics and Concepts

Delivering structural concepts, testing, and analyses

LaRC – Research Directorate



New concepts for on-orbit assembly, repair and manufacturing

Large-scale mechanical and thermal testing capability



Experimental Methods Development

Developing advanced fabrication methods to build tow-steered composites



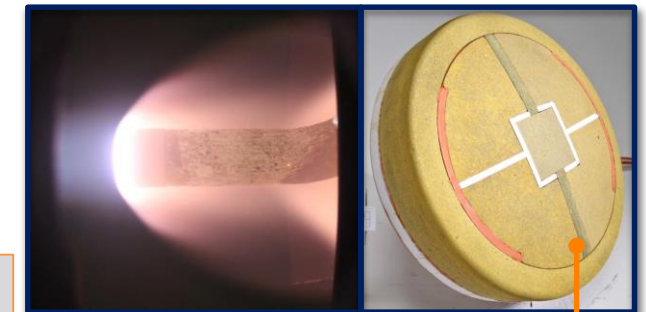
Advanced Fabrication Methods

Critical analyses of advanced aerospace vehicles

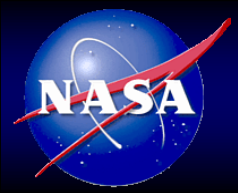


Analysis Methods Development

Design and testing of advanced thermal protection systems and hot structures concepts



Thermal/Structural Technology Development



Structural Mechanics and Concepts Branch Facilities & Competencies

LaRC – Research Directorate

- **Large Structures and Thermal Structures Lab**

- 17 uniaxial test stands (Range from 1 kip to 1 Mlb)
- Environmental chambers from -423°F to 1000°F
- 10-ft by 30-ft T-slotted steel reaction surface
- HYMETs – Arcjet that can achieve 3000°F

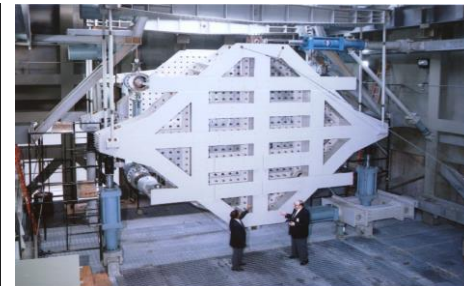
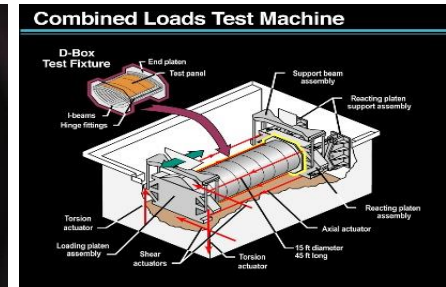
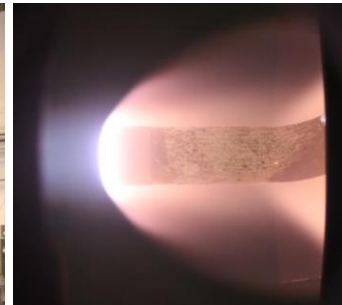
- **Flat floor that simulates zero-G**

- **ISAAC automated fiber placement system (AFP) in an ISO 7 clean room**

- **Combined Loads Test System (COLTS)**

Core Competencies

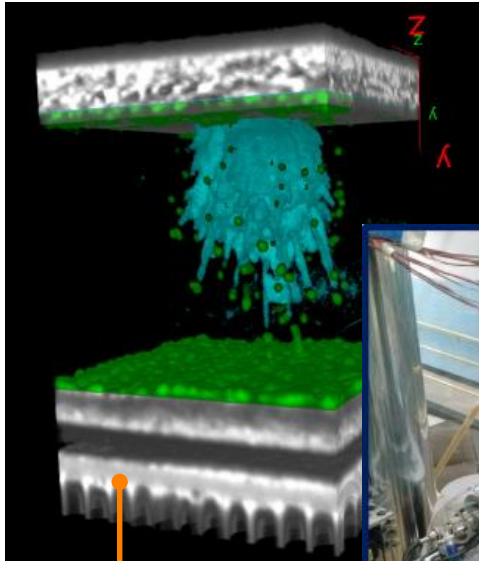
- Structural mechanics
- Heat transfer theory
- Thermal protection systems (TPS) and hot structures concepts for aerospace applications
- Structural concepts
- Multi-functional concepts
- Advanced fabrication methods at ISAAC (Integrated Structural Assembly of Advanced Composites) to build tow-steered composites



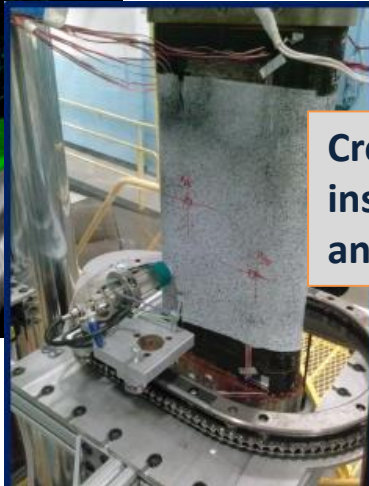


Advanced inspection solutions for Agency challenges

LaRC – Research Directorate

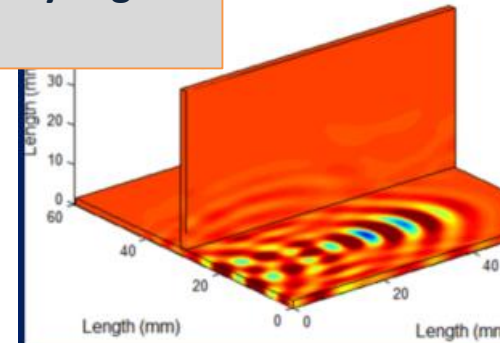


Advanced and Emerging NDE Solutions

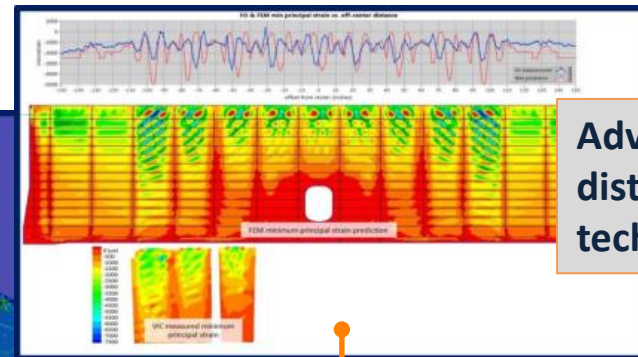
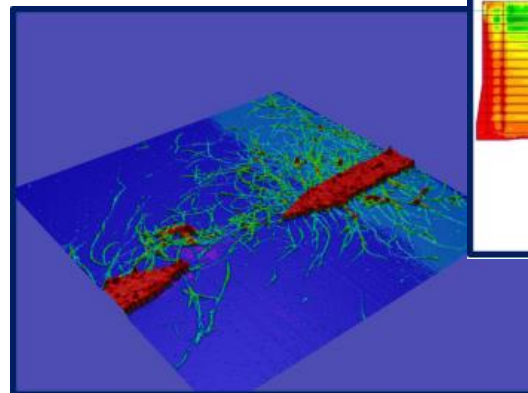
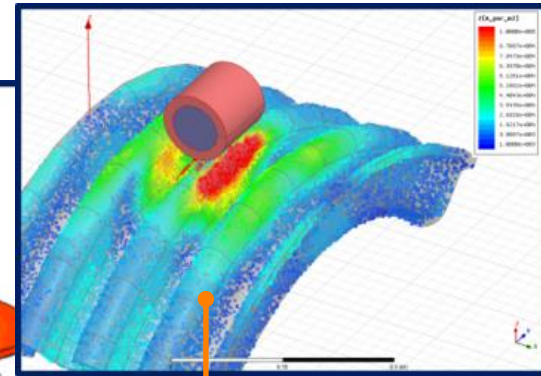


Creating novel solutions for inspection of advanced materials and unique aerospace structures

Developing validated computational tools for predicting, optimizing and analyzing inspection methods and results



Physics Based Modeling and Advanced Data Analysis



Advancing in-situ and distributed sensing technology and methods

Structural Health Monitoring Sensor Implementation and Interrogation



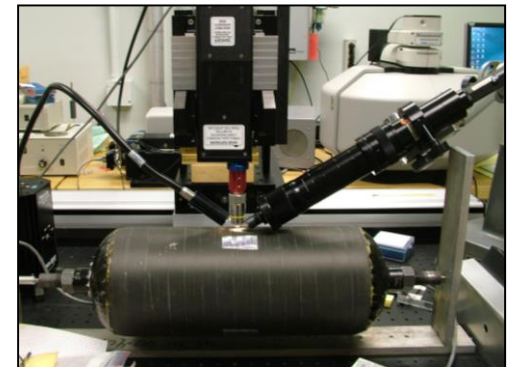
Nondestructive Evaluation Sciences Branch Facilities & Competencies

LaRC – Research Directorate

- Large Area Scanning Systems Lab
- Thermal Imaging Lab
 - Flash, step, scanning, passive, vibro
- Ultrasonic Lab
 - Immersion, non-immersion, phased-array, nonlinear ultrasound
- Electromagnetics Labs
 - Eddy Current, Terahertz Imaging
- Computed X-Ray Tomography Facility
 - Microfocus to $<5\mu\text{m}$ resolution
 - 7 foot working envelope
- MEMS and Nano Sensor Fabrication
 - Direct write photolithography
- Photo & Thermal Elasticity
- Scanning Electron Microscopy
- Raman Spectroscopy
- NESB and LaRC high performance computing resources for NDE modeling/data analysis

Core Competencies

- Advanced NDE Solutions
 - Unique solutions using state-of-the-art NDE technologies such as Eddy Current, Ultrasound, Thermography and X-ray CT
- Emerging NDE Technologies
 - Unique NDE technologies such as Terahertz, wavefield imaging, nonlinear ultrasound, Raman spectroscopy
- Physics Based NDE Modeling
 - Developing custom simulation code and leveraging commercial tools
- Advanced Data Analysis and Interpretation
 - Physics based and data driven methods to interpret large data sets
- SHM Sensor Implementation and Interrogation
 - Advanced methods of applying and interrogating sensors for structural health monitoring, and system capability assessment





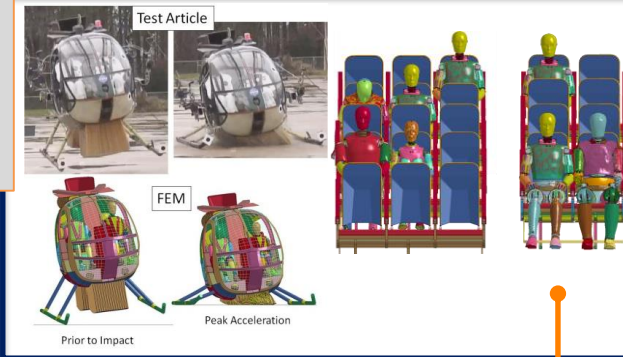
Structural Dynamics

Evaluating structural responses from launch to in-space to landing

LaRC – Research Directorate

Developing airframe crashworthiness;
landing impact dynamics; occupant
response

Develop and validate
analytical and experimental
methods

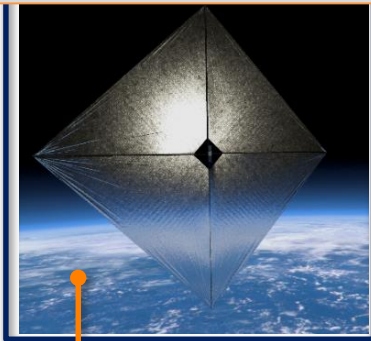


Nonlinear Structural
Dynamics Analysis

Evaluating dynamic response
of aerospace structural
systems

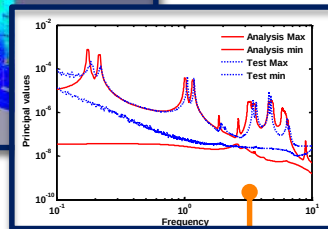
Structural Dynamics
Experimental Methods

Building large, deployable
space structures



Multi-Functional
(Active) Structures

Uncertainty-Based
Analysis



Dynamic Materials
Characterization



Structural Dynamics Facilities & Competencies

LaRC – Research Directorate

- **Structural Dynamics Research Facility (SDRF)**
 - Flat floor high bay
 - Large scale deployable structures
 - Vacuum chamber (16 m, 8 ft test sections)
- **Landing and Impact Research Facility (LandIR)**
 - 240 ft gantry structure
 - 20 ft deep Hydro Impact Basin
 - 15 ft, 30 ft, 50 ft drop towers
 - Load testing machines
 - Anthropomorphic Test Devices

Core Competencies

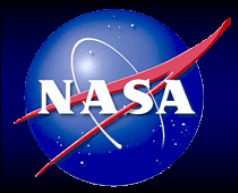
- Membrane, inflatable, & ultra-thin structures
- Nonlinear materials characterization
- Uncertainty-based analysis
- Multi-terrain impact dynamics/crashworthiness
- Occupant injury Biomechanics
- Novel photogrammetric techniques

SDRF



LandIR





LaRC – Research Directorate

QUESTIONS?