

The background of the slide is a composite image. The upper portion shows a deep space scene with a large, detailed Earth's moon in the center-left, a smaller reddish planet (Mars) in the top-left, and a small spacecraft with a bright blue engine plume moving from the moon towards the right. The sky is dark blue and black, filled with numerous white stars. The lower portion of the slide transitions into a silhouette of a person's head and shoulders, looking out over a landscape under a sunset or sunrise sky with orange and yellow clouds.

**EXPLORESpace TECH**  
TECHNOLOGY DRIVES EXPLORATION

# Historical Perspective and the Future of Composites for NASA Missions

## Joint Composite & Advanced Materials Sustainment (JCAMS) Annual Meeting

John Vickers | Principal Technologist, Space Technology Mission Directorate | June 13, 2023

# How We Explore... NASA Mission Directorates



**Exploration Systems  
Development**



**Space Technology**



**Aeronautics Research**



**Space Operations**



**Science**



# SPACE TECHNOLOGY PORTFOLIO

## EARLY STAGE INNOVATION AND PARTNERSHIPS

- Early Stage Innovation
  - Space Tech Research Grants
  - Center Innovation Fund
  - Early Career Initiative
- Prizes, Challenges & Crowdsourcing
- NASA Innovation Advanced Concepts

## SBIR/STTR PROGRAMS

- Small Business Innovation Research
- Small Business Technology Transfer

## TECHNOLOGY MATURATION

- Game Changing Development
- Lunar Surface Innovation Initiative

## TECHNOLOGY DEMONSTRATION

- Technology Demonstration Missions
- Small Spacecraft Technology
- Flight Opportunities

Technology Drives Exploration

LOW

MID

Technology Readiness Level

HIGH

# Develop Technologies Supporting Emerging Space Industries



*Priorities - Targeted advanced manufacturing outcomes aligned with space industry trends that will shape the course of research and development over many years*

## In-Space Manufacturing and Space Infrastructure



A catalyst for space infrastructure and economic opportunities  
> 50% Mass reduction, > 99% 3D printer readiness.

1

## 3D Printing / Additive Manufacturing



Revolutionized product design and manufacturing  
>50% Cost reduction, accelerated time to market

2

## Digital Transformation Digital Twins and Artificial Intelligence



More intelligent and more accurate predictions and capabilities  
>50% of physical resources replaced with virtual

3

## Lightweight Composite Spacecraft



High high strength-to-weight ratio and dimensional stability  
50% More payload, equipment, and experiments

4



# Back in Time Machine



# NASA Composites Capability

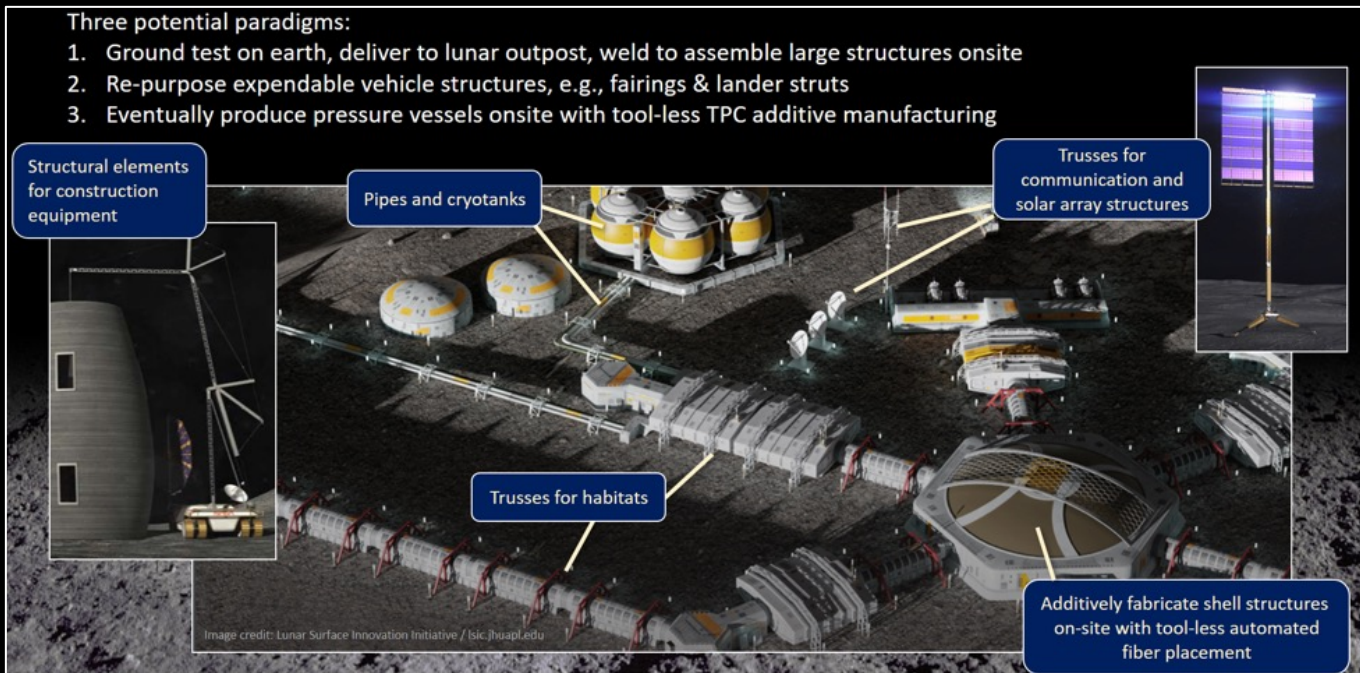


# Thermoplastic Composites



## Thermoplastic Composites for In-space Applications

- NASA/STMD effort to develop thermoplastic composites manufacturing and joining technologies for eventual in-space/on-orbit applications.



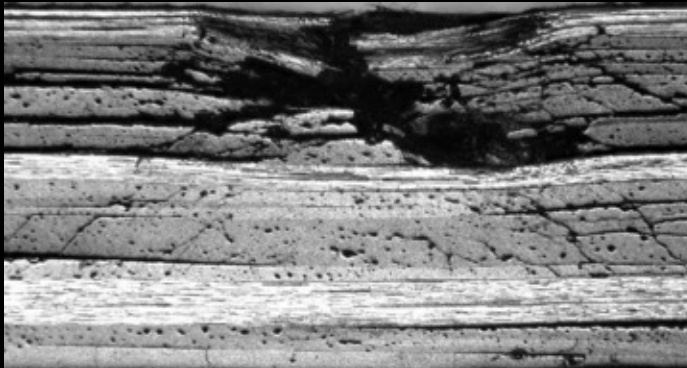


# Composite Motor Cases



## Composite Motor Cases for SLS Solid Rocket Boosters

- NASA/Northrop Grumman joint effort to develop composite motor cases to replace Shuttle Program-heritage steel cases
- Notable accomplishments and ongoing tasks:
  - Carried out comprehensive damage tolerance assessments for IM7 and T1100 carbon fibers to aid in material down-select.
  - Developing improved manufacturing and test techniques to better characterize filament wound composites.
  - Working with Northrop Grumman to serve as a sub-scale development partner, which reduces risks for Northrop Grumman and SLS as a whole.





# Overwrapped Thrust Chambers



## Composite Overwrapped Thrust Chambers

- NASA/STMD effort to mature novel additive and composites manufacturing techniques to reinforce regen-cooled thrust chamber assemblies via composite overwraps.
- Notable accomplishments:
  - Developed manufacturing processes for 2k, 7k, and 40k combustion chamber hardware, where chambers were additively manufactured and overwrapped with carbon fiber composites.
  - Successfully hot fired 2k and 7k composite overwrapped combustion chambers.

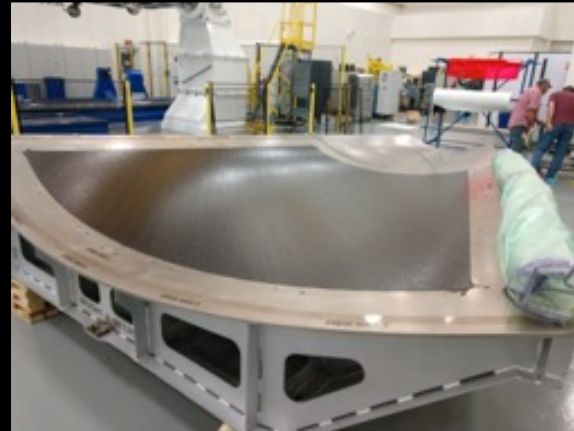


# SLS Payload Adapter



## SLS Block 1B Payload Adapter

- NASA effort to produce Payload Adapter flight units for SLS Block 1B.
- Composite sandwich structure built in 8 segments.
  - T1100 carbon fiber used throughout the structure.
  - Automated fiber placement (AFP) used to lay up facesheets.
  - Segments joined together via adhesively bonded double strap joints (non-redundant, primary load path, fracture critical).





# The James Webb Space Telescope's Backplane



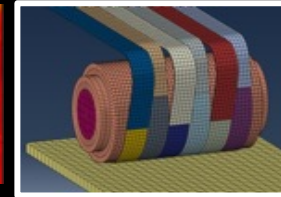
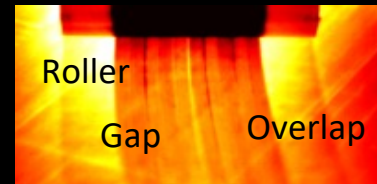
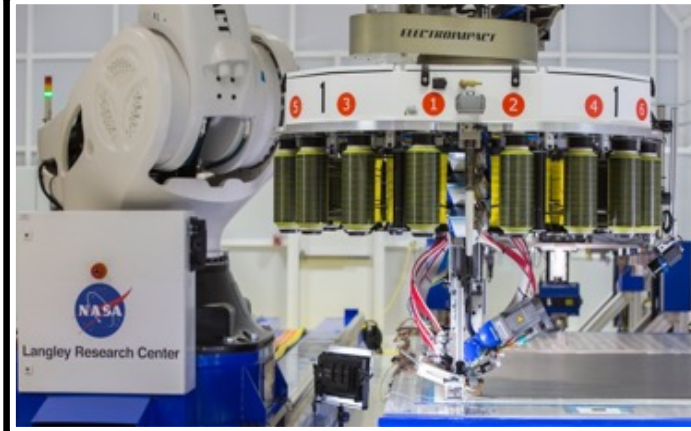
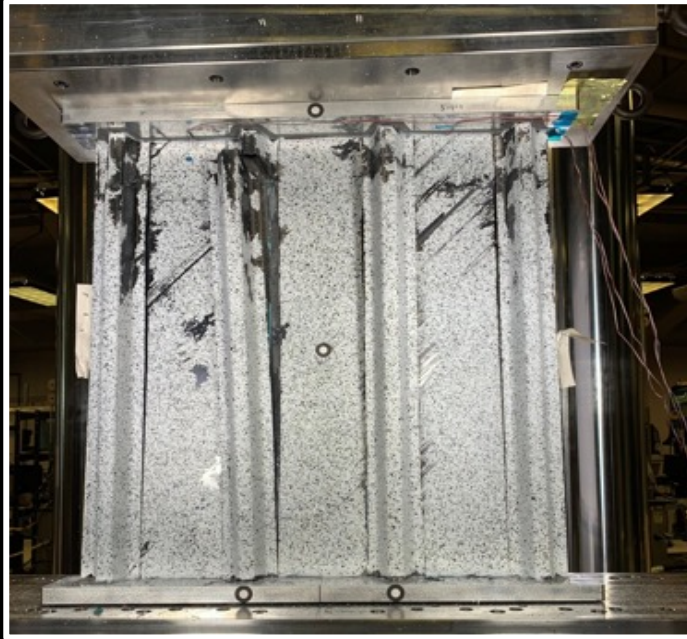
*The backplane carries more than 2400kg (2 1/2 tons) of hardware, it performs at temperatures colder than -400°F (-240°C) with unprecedented thermal stability within 32 nanometers, which is 1/10,000 the diameter of a human hair!*



# Mars 2020 Perseverance Rover & Helicopter Ingenuity

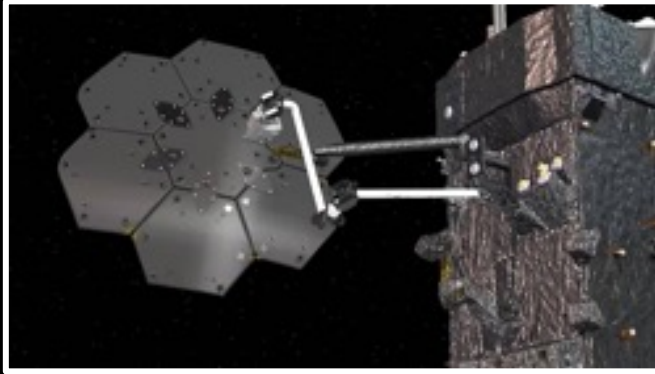


# Remaining Competitive in Aircraft Manufacturing



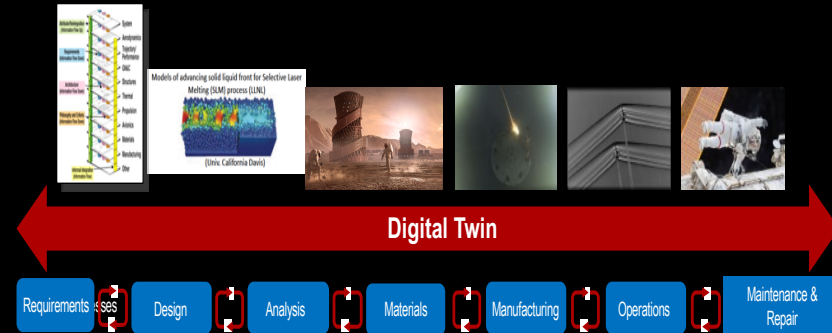
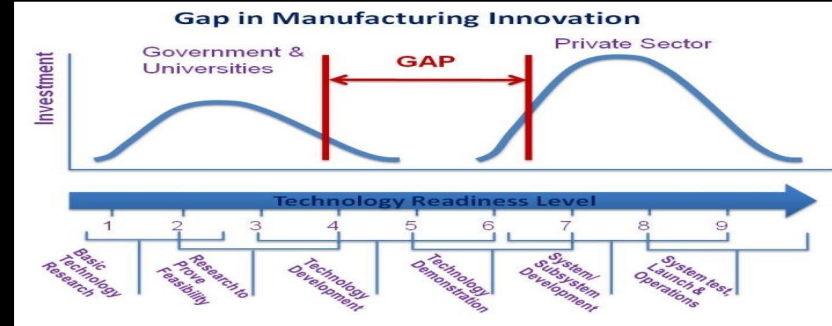
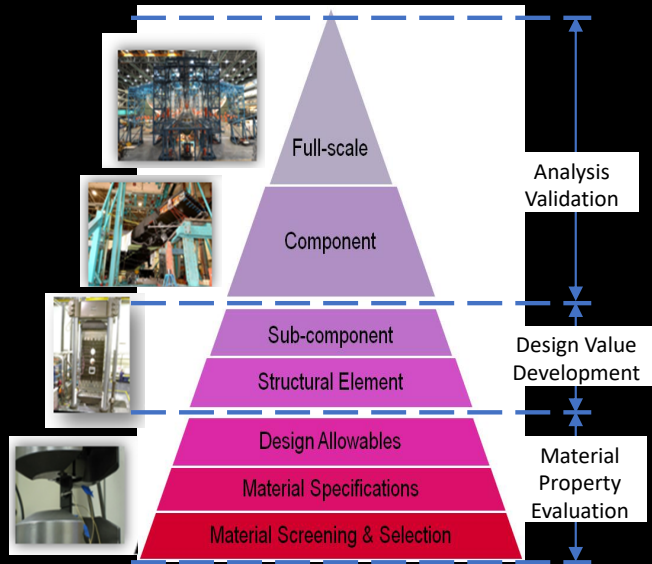
- Advanced Composites Project completed after a 5 year research effort and \$170M investment
- Hi-Rate Composite Aircraft Manufacturing (HiCAM) (in formulation in FY21)
- Reducing time to develop & certify composite structures
- Partnerships between government, industry and academia

# In-Space Manufacturing





# Digital Manufacturing



**Product Development, Testing and Certification Today**

*"It takes too long and costs too much to certify aerospace structures" - Exhaustive testing done to support analysis*

# Funding Opportunities and Announcements



NASA's Notices of Funding Opportunities are located in the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES) and TechPort  
(<https://nspires.nasaprs.com>)  
(<https://techport.nasa.gov/home>)



Showing 1 to 19 of 19 entries

| Title  | Number                            | Sponsor Org    | NOI Due | Prop Due   |
|--|-----------------------------------|----------------|---------|------------|
| A.2 Land Cover/Land Use Change - Multi-Source Land Imaging                 | <a href="#">NNH23ZDA001N-GLUC</a> | NASA/HQ-SMD-ES | --      | 05/23/2023 |
| A.46 Earth Science Applications: Ecological Conservation Impact Assessment | <a href="#">NNH23ZDA001N-ECIA</a> | NASA/HQ-SMD-ES | --      | 05/24/2023 |

| Funding Opportunity                       | Average Project Funding | Average Duration (Months) | Frequency       | Next Opportunity | Mission Directorate | Topic-Specific or Open |
|---|-------------------------|---------------------------|-----------------|------------------|---------------------|------------------------|
| Announcement of Collaboration Opportunity | \$1,000,000             | 24                        | Every 2-3 years | TBD              | STMD                | Topic                  |
| BSG Idea Challenge                        | \$180,000               | 9                         | Annual          | 2024/E1          | STMD                | Topic                  |
| Centennial Challenges                     | \$500,000               | 36                        | Ongoing         | Ongoing          | STMD                | Topic                  |
| Early Career Faculty                      | \$400,000               | 36                        | Annual          | 2024/E2          | STMD                | Topic                  |
| Early Stage Innovations                   | \$400,000               | 36                        | Annual          | 2023/E5          | STMD                | Topic                  |



# QUESTIONS?

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