NASA Automated Fiber Placement Capabilities: Similar Systems, Complementary Purposes

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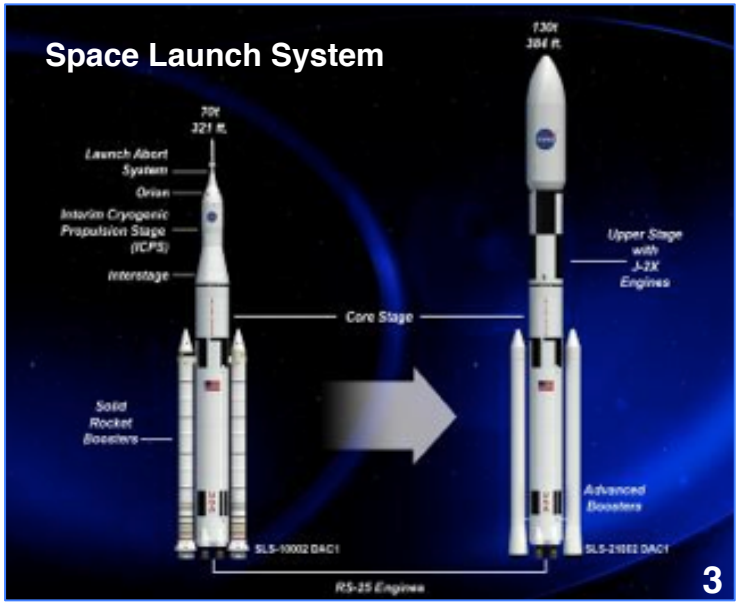
Outline

- Why composites?
- Automated fiber placement (AFP)
- Composite Cryotank Technology Development (CCTD) Project
- LaRC and MSFC capabilities
- Composites for Exploration Upper Stage (C-EUS) Project
- Concluding Remarks

Composites Support NASA and the Nation

- All NASA Mission Directorates: Aeronautics Research, Human Exploration and Operations, Science, Space Technology
- Advanced Manufacturing National Initiative, and National Network for Manufacturing Innovation
- Other US Government Agencies: DOD, DARPA, DOE
- Identified in NASA Space Technology roadmap Technology Area 12 (Materials, Structures, Mechanical Systems & Manufacturing)
- Span multiple NASA Centers and disciplines
- Engage Industry and Research communities

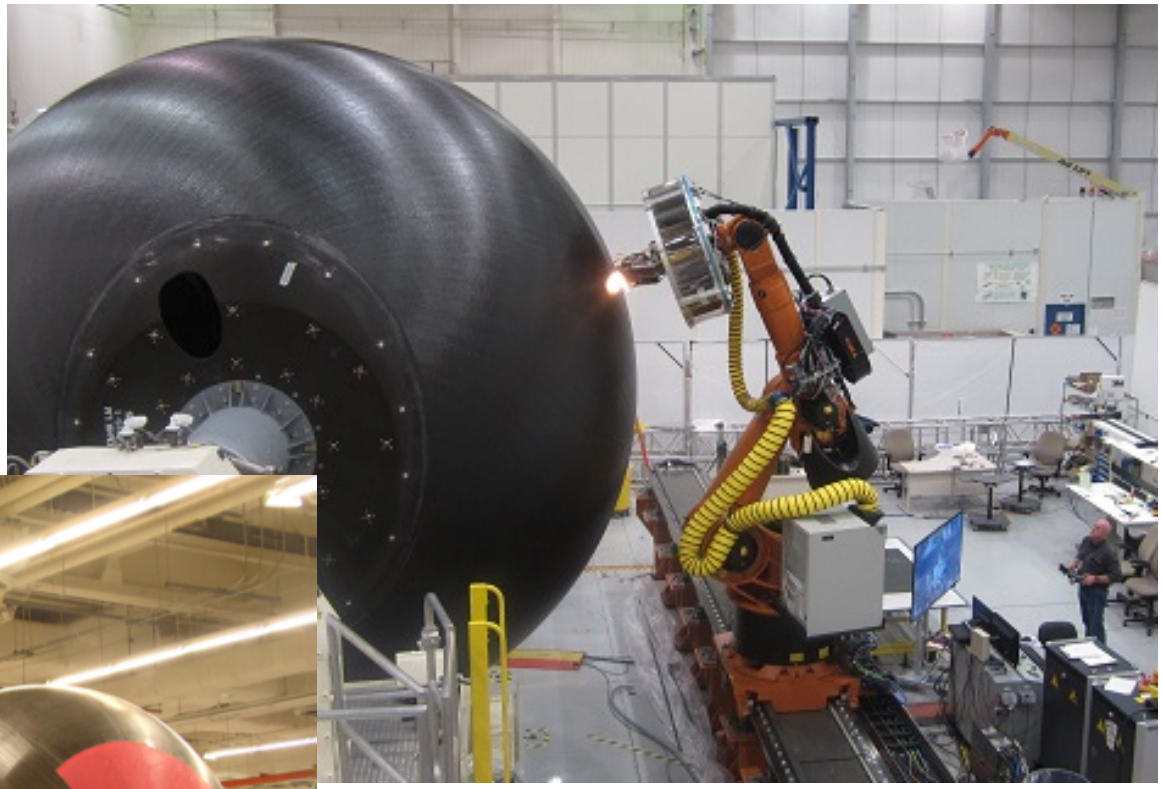


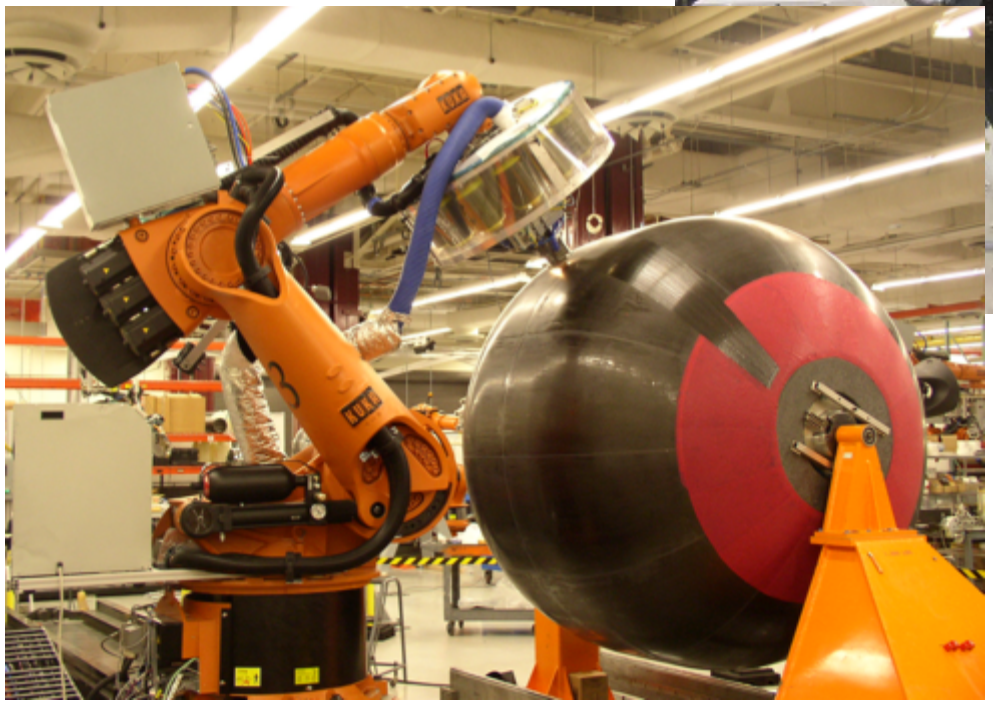
AFP Overview

- Process developed in 1980's
- Can process either thermosets or thermoplastics, using prepreg materials in slit tape or tow forms
- Can perform fast, precise, accurate lamination on tooling, following preprogrammed paths
- Gaps, laps, twisted tows, fuzzballs, etc. are all par for the course
- Robotic mobility platforms are game changers, reducing entry cost by at least a factor of 2

CCTD Project Composite Tanks

Design, build and test large prototype composite cryotanks for use on future launch vehicles



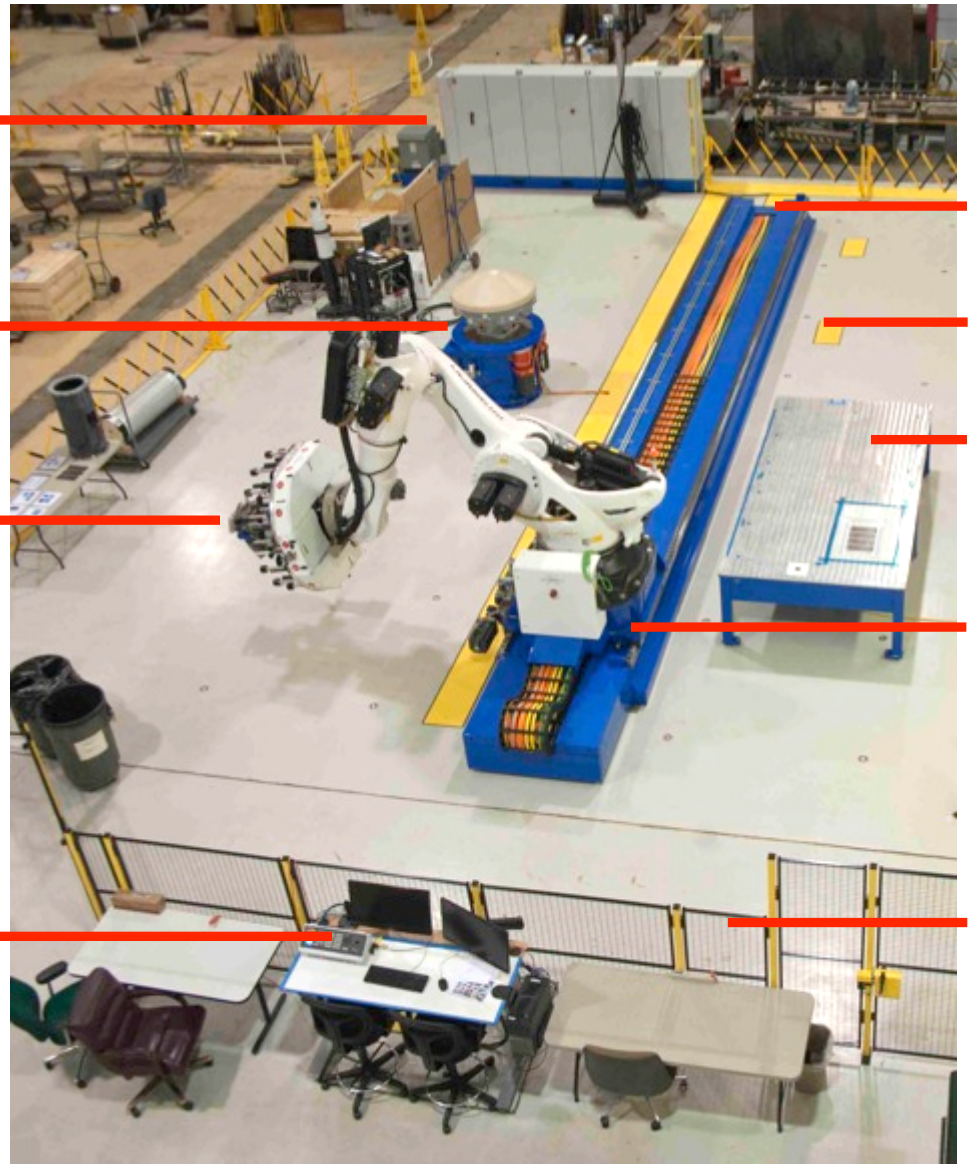


Two composite cryotanks (2.4-m and 5.5-m diam.) built using AFP, and tested at MSFC in 2014

AFP Capabilities at LaRC and MSFC

- Independently procured similar robotic AFP systems (both approx. 12 ft by 12 ft by 33 ft work envelopes)
- LaRC system delivered and installed Fall 2014, and commissioned January 2015
- MSFC system delivery and installation late Spring 2015
- LaRC has a small vertical rotator, MSFC has a large horizontal rotator (headstock/ tailstock)
- LaRC planning cleanroom procurement for late 2015

LaRC Fiber Placement System



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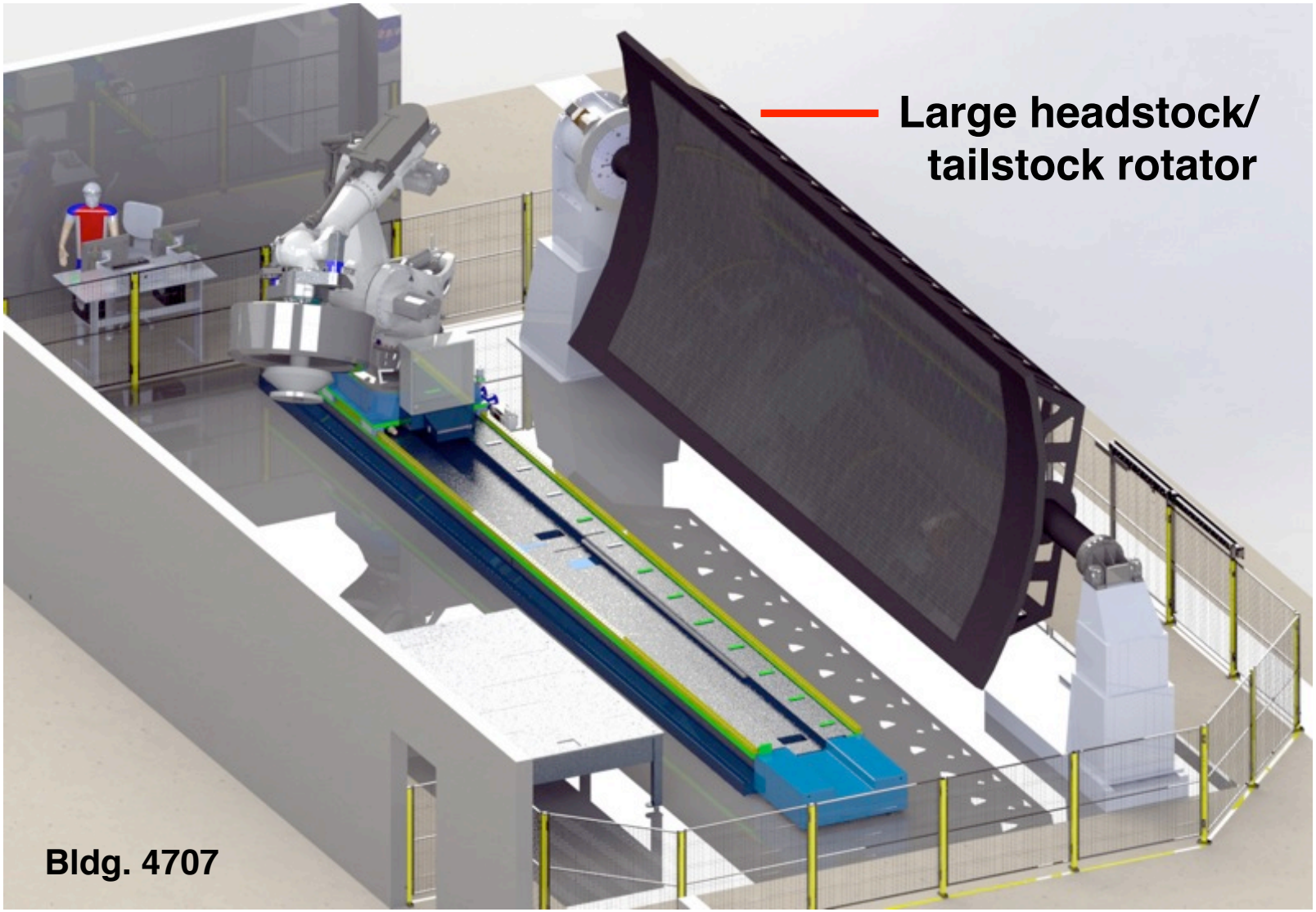
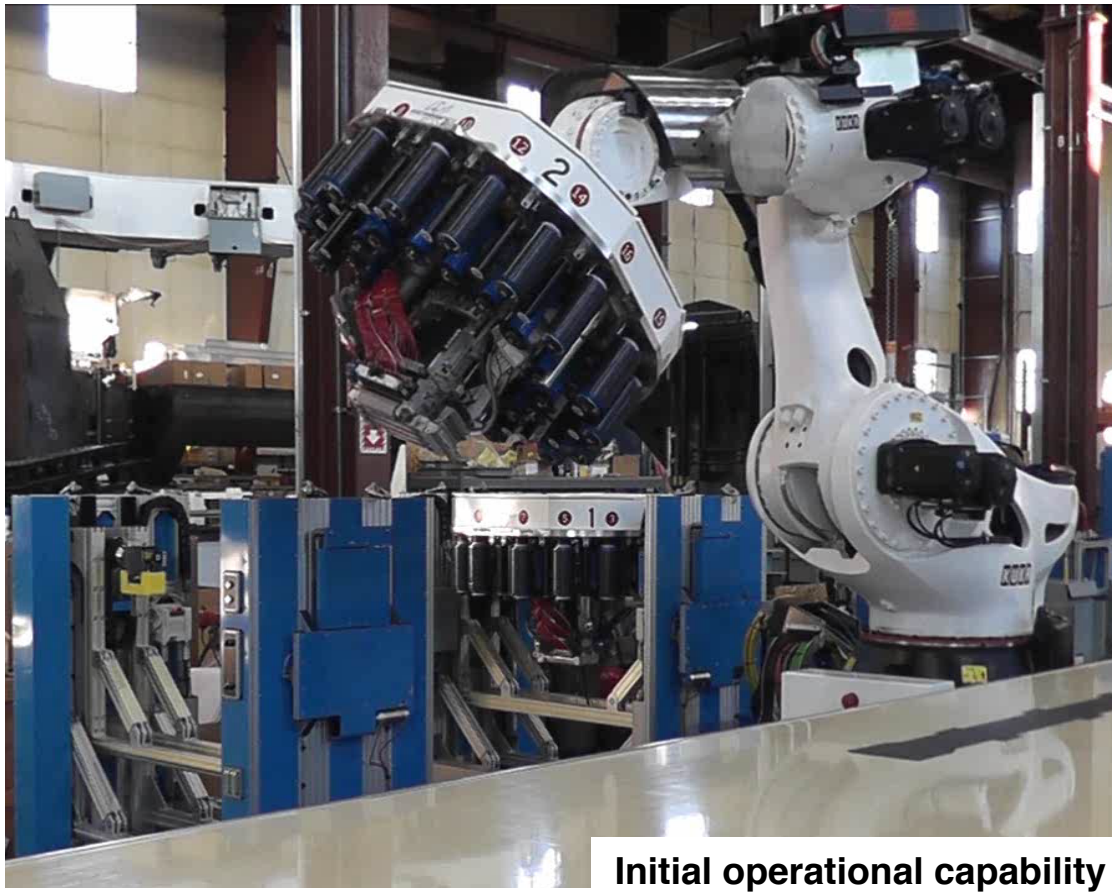
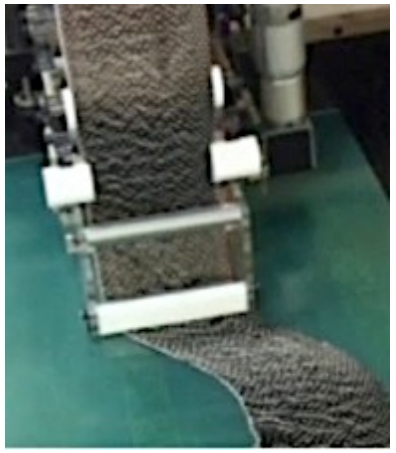
MSFC Fiber Placement System

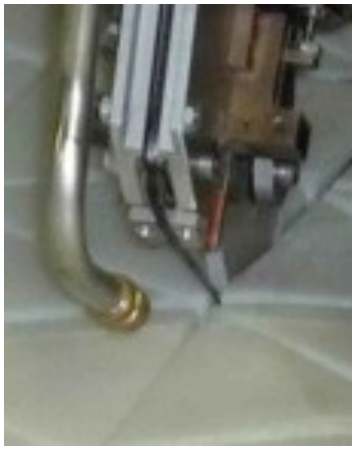


Flexible AFP System Architecture



Initial operational capability





Robot-based system allows multiple end effectors for assessing new composite materials, processes, structural concepts, manufacturing, and inspection techniques

Proposed end effectors include (clockwise from top): machining, grid-stiffening, and continuous tow shearing capabilities

Integrated Capabilities Across TRL* Range

** TRL = Technology Readiness Level*

TRL 1-3

Develop
New Resins
and Fibers

Pre-Pregging of New
Composite Materials

Develop Advanced In-Process,
In-Situ NDE and Fabrication
Technologies

Basic Research

LaRC

Applications

MSFC

Technology Maturation

Manufacture
Launch Vehicle
Structures for
NASA Missions

TRL 7-9

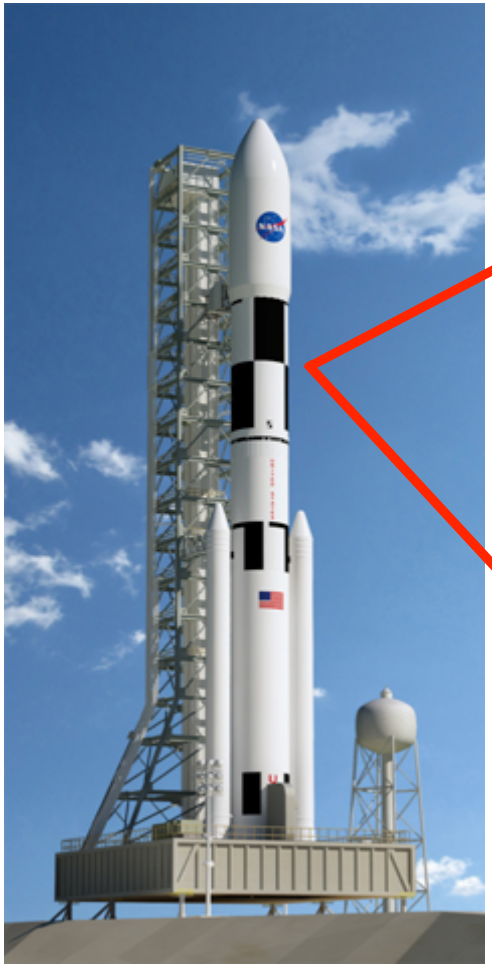
Design, Build and Test
Proto-flight Structures

Post-Cure Characterization
and NDE of Composites

TRL 4-6

Design and Fabrication of
Advanced Structural Concepts

C-EUS Project



SLS block 2 upgrade

New Upper Stage

Design, build and test prototype composite skirts for future Space Launch System (SLS) upgrade

LaRC planning to build flat and curved panels for concepts, technology development and testing of structural joints

MSFC planning to build large curved panels for fabrication and testing of full-scale structural test article(s)

Concluding Remarks

- New robotic AFP platforms provide state-of-the-art composites capabilities for NASA Centers
- Flexible AFP system architecture allows development and implementation of advanced-capability end effectors
- AFP systems can support the full TRL spectrum from basic research to flight hardware
- With these AFP capabilities, LaRC and MSFC are well-positioned to support many NASA projects and programs