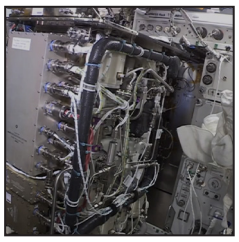
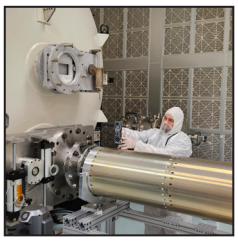
National Aeronautics and Space Administration

Marshall Space Flight Center

# Mechanical and Optical Design, Analysis, and Fabrication

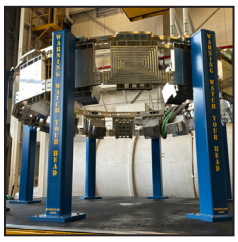


ISS Environmental Control and Life Support System Flight Hardware

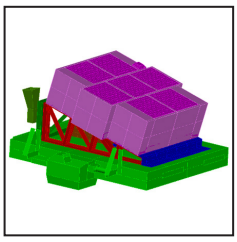


MaGIX-2 Testing in Stray Light Test Facility

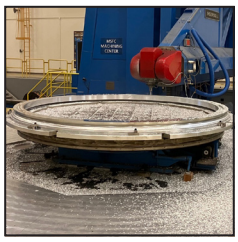
Mighty Eagle Prototypes, Demonstrators



Artemis Nest – Secondary Payloads



Science Instruments, Design & Analysis



Mechanical Fabrication – 7-axis Machining Center

The Mechanical and Optical Design, Analysis, and Fabrication Division provides comprehensive mechanical and aerospace engineering expertise in design, analysis, fabrication, assembly, and integration. The division delivers structural, mechanical, optical, thermal, and fluid system hardware for advanced technology implementation, small spacecraft, critical ground hardware, science investigations, and exploration initiatives.

**The Structural and Mechanical Design Branch** provides mechanical and structural design, development, and early testing for development and flight hardware as well as ground support and special test equipment. Mission types include:

- Space Environmental Control and Life Support Systems (ECLSS) and science and technology experiments
- Structures and mechanisms as well as integrated design activities for robotic and crewed low-Earth orbit and exploration payloads and spacecraft
- Optical experiments and supporting systems for in-space telescope or observatory-class missions or terrestrial balloon missions
- Large vehicle structures for ground support and transportation
- Design and delivery of test articles and breadboard units for diverse technology development efforts

**The Thermal and Mechanical Analysis Branch** performs structural, dynamic, and thermal analyses for flight and ground systems. Structural areas include stress, stability, fracture, and fatigue analyses. Structural dynamics areas include traditional low- and high-frequency response analyses for environmental test predictions, multibody and advanced non-linear dynamics, and benchtop dynamic testing for model correlation. The thermal areas encompass traditional conduction, convection, in-space radiation, fluid dynamics, and multi-physics assessments. Thermal assessments also include the design and evaluation of active/passive thermal control systems and thermal protection systems. Analysts provide extensive support and use of testing to develop, refine, and verify structural and thermal designs.

**The Optical Systems Design and Fabrication Branch** specializes in the design, development, and manufacture of Grazing Incidence (GI), and Normal Incidence (NI) optics to fulfill the needs of the NASA Science Mission Directorate and other entities. The branch engages in specialized fabrication, processing, polishing, metrology, and replication to produce optical products and systems for future science missions and the scientific community. We are a vital participant in manufacturing and testing optics for a wide range of customers. Partnerships has existed with NASA/GSFC, NASA/KSC, Dept. of Energy, National Institute of Health, National Ignition Facility, National Institute of Standards and Testing, DARPA, SAO, MIT, UC Berkley, University of Iowa and others. The Branch operates three unique facilities the Optical Fabrication Shop, the Electroforming Replication Facility, and the Stray Light Test Facilty. The Optical Fabrication Shop includes but is not

limited to precision CNC machines, two types of electrical discharge machines (EDM), two single-point diamond-turning machines, CNC robotic polishers, interferometers, and a coordinate-measuring machine. The Electroforming Replication Facility provides the electroforming replication technology for producing high quality, full-shell grazing incidence X-ray mirrors. The Stray Light Test Facility (SLTF) vacuum system performs optical instrument testing and calibration inside a 10,000-square-feet clean room.

**The Mechanical Fabrication Facility** provides in-house fabrication capability and fabrication outsourcing services for Marshall. The machine shop, with floor space of approximately 35,000 square feet, has the capability of producing very large, high-precision parts. It contains machinery such as conventional lathes and mills, CNC lathes and mills, including a large 7-axis machine, and CNC electrostatic discharge machines (EDM wire and plunge). The group provides precision assembly and cleaning capabilities for research development, test, and flight hardware.

**The Stray Light Test Facility (SLTF)** vacuum system performs optical instrument testing and calibration inside a 10,000-square-feet clean room.  It provides a unique suite of x-ray sources and detectors for a wide variety of x-ray tests. The SLTF has a 100-m beamline opening into a 12-m long by 3-m diameter instrument chamber. This short beamline gives the SLTF higher flux rates, especially with soft x-ray sources. The SLTF design and operational approach provides quick access to scientists and instrument developers, resulting in rapid turnaround times and offering a cost-effective, flexible approach that typically reduces the overall test schedule.

**The Mechanical Development Facility** provides a safe, controlled environment for the assembly and evaluation of development engineering and prototype hardware. The facility is used for breadboard build-ups, mechanical system checkouts, and hardware mock-ups. The facility contains basic metal fabrication equipment, providing designers and analysts the capability to manufacture a wide variety of test hardware. This facility also has the capability of producing rapid prototypes with a rapid prototyping machine. The facility offers lab space and basic testing equipment, such as thermal vacuum chambers and mechanical test equipment, to perform early concept thermal and mechanical testing.

**The Hub for Innovative Thermal Technology Maturation and Prototyping (HI-TTEMP)** provides for developmental testing of thermal technologies at Marshall, which informs design and analysis decisions to create more accurate analysis based on ground truth; reduces overall design cycles; and enables quick responses to project and partnership needs with rapid testing. Developmental testing done in HI-TTEMP also generates new thermal technologies to be applied to current and future missions, creating new work internally and allowing engineers to mature their own innovative ideas and push to improve the state-of-the-art of thermal control technology in the process. HI-TTEMP has also encouraged collaboration across NASA organizations and with industry partners who have a need for quick developmental thermal testing. The HI-TTEMP hub offers benchtop testing, multiple sizes of vacuum chambers, a range of cooling and heating hardware, data collection and acquisition tools, standard test fixture materials, and light fabrication.

## Summary of Key Mechanical and Optical Design, Analysis, and Fabrication Division Capabilities

- Designs, analyzes, and optimizes mechanisms and structures experiment hardware, payloads, subsystems, spacecraft (traditional, small, and micro satellites) and robotic or crewed planetary for atmospheric and spaceflight missions
- Designs, analyzes, and routes electrical and mechanical (fluid) lines between components
- Fabricates, assembles, and calibrates grazing incidence and replicated optics
- Designs and analyzes optics for space telescopes
- Designs and analyzes primary and secondary structures, including composites
- Analyzes structural designs in terms of stress, fracture and fatigue, and strength verification
- Defines component and system vibration, acoustic and shock environments; designs, develops, and evaluates vibration mitigation solutions; characterizes and assesses dynamic performance of mechanisms
- Defines thermal environments and behaviors and designs

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