National Aeronautics and Space Administration

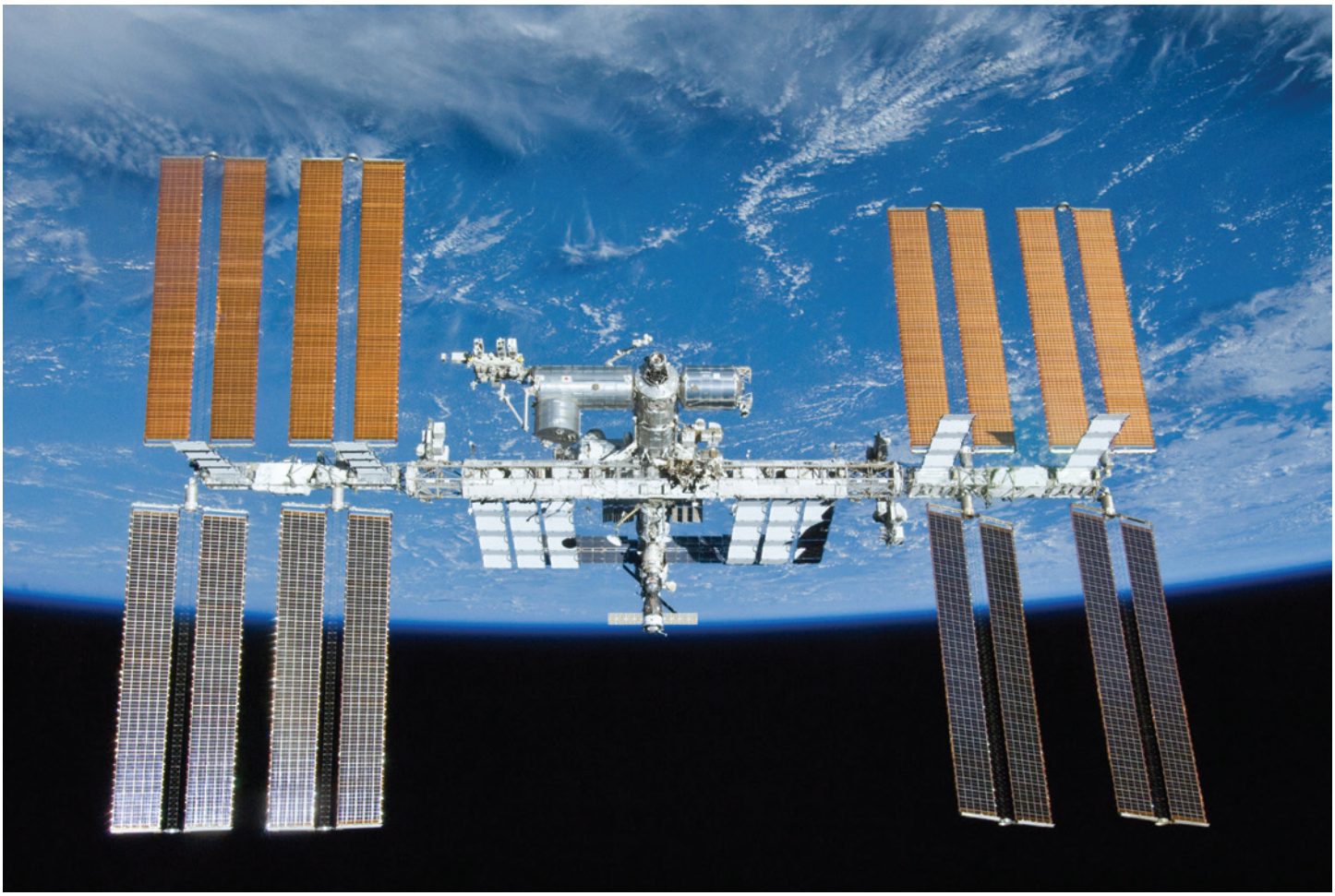
Payload Systems

Proven Processes Reduce Cost and Time

Marshall Space Flight Center has proven processes to design, develop, test, and integrate payloads for on-orbit operations. Programs such as Shuttle and International Space Station (ISS) have very stringent verification requirements, and Marshall has matured its capability to meet these requirements consistently. As a result, sole verification responsibilities have routinely been delegated to the Center. Because of the Center's engineering and systems integration expertise and understanding of customer requirements and environmental conditions, Marshall's validation, verification, and flight certification processes are well regarded. Because Marshall's processes have been optimized internally, verification and validation tests are performed efficiently, resulting in schedule savings. Flight opportunities are limited and often scheduled years in advance. Missing a window for the next launch vehicle can be costly, but because Marshall payloads do not require additional testing at the program level, there are additional schedule savings.

At-A-Glance

Marshall has a rich heritage in the development and testing of payloads, racks, systems, and components. The Center's reliable and demonstrated processes result in efficient payload delivery and successful teaming with international partners, academia, other NASA centers, and industry. Marshall's expertise and unique facilities serve as a conduit for reliable and effective advancement of payload development and demonstration.



Unique human spaceflight safety requirements have led to implementation of rigorous Marshall safety processes and requirements. Each project has a safety engineer matrixed to the team. Payloads are taken through a process of very robust requirements. Marshall develops and integrates safety data packages, which are presented for review and approval by multilevel boards following a governance process.

Marshall also performs end-to-end tests allowing earlier identification of problems and time for the payload team to correct issues before on-orbit operations. Crew time is extremely expensive and limited, so effective ground-based troubleshooting is critical.

Expertise with On-Orbit Research Facilities

Marshall has a deep heritage in engineering and payload management that dates back to Skylab and Spacelab. The Center designs, develops, manufactures, tests, operates, manages projects, and interfaces with the customer organization. Because of Marshall's role in developing and operating these facilities, the Center offers unique insight and expertise to payload developers who need to integrate with them on-orbit.

Marshall's test suite is connected to the Huntsville Operations Support Center (HOSC) for full software verification and validation checkout. Marshall is the only center that provides this unique capability to the Agency, enabling true end-to-end testing of payload telemetry.

Marshall's expertise is demonstrated and enriched by its ISS research facilities, such as the EXPRESS suite of racks, Microgravity Science Glovebox, and the Material Science Research Rack-1. The Center's development and operation of these facilities allows insight and expert integration of systems and processes required to deliver on-orbit payloads. The EXpedite the PRocessing of Experiments to the Space Station (EXPRESS) Rack is a standardized payload rack system that transports, stores, and supports experiments aboard the ISS. It was developed specifically to maximize the station's research capabilities by providing small payloads with a shortened integration time. With its standardized hardware interfaces and streamlined approach, the EXPRESS Rack enables quick, simple integration of multiple payloads aboard the ISS, resulting in easier and more affordable delivery of payloads.

The Microgravity Science Glovebox (MSG) enables scientists from multiple disciplines to participate actively in the assembly and operation of experiments in space with much the same degree of involvement they have in their own research laboratories. Developed by the European Space Agency (ESA) and managed by Marshall, the MSG was launched to the ISS in June 2002. This facility offers an enclosed 255-liter (9-cubic-foot) work area accessible to the crew through glove ports and to ground-based scientists through real-time data links and video. Because the work area is sealed and held at a negative pressure, the crew can manipulate experiment hardware and samples without the danger of small parts, particulates, fluids, or gasses escaping into the open laboratory module. To date, the MSG has performed over 22,000 operational hours of scientific research.

EXPRESS allows rapid integration of multiple payloads, streamlining payload operations.

The Material Science Research Rack-1 (MSRR-1) is an International Standard Payload Rack outfitted with custom-designed subsystems to provide ground controllers or the onboard crew with the capability to monitor and control high-temperature material research. Marshall designed and developed the subsystems to accommodate the operations of the MSRR. Marshall also performed the hardware/software integration, testing, and verification necessary to certify the facility for flight.

Stand-Out Facilities

The Space Systems Integration and Test Facility is a unique multipurpose facility that enables the design and development of space systems from proof-of-concept studies, prototype and development hardware check-out, integration and assembly of flight systems, and qualification and acceptance testing of components, subsystems, and integrated systems through real-time operations of on-orbit payloads. To implement these functions, the facility incorporates a 10,000-square-foot temperature- and humidity-controlled high-bay work area. The high bay is fully equipped for handling flight hardware.

A Payload Rack Checkout Unit (PRCU) is used for verification and validation of ISS-class payloads and sub-rack payloads. The PRCU, located in the Space Systems Integration & Test Facility, provides a high-fidelity emulation of ISS resources including command and data handling, power, cooling, video, vacuum, and gas distribution.

Payload developers utilizing the EXPRESS racks can test their payload's software with a portable version simulating the software used at the PRCU. The RAPTR, or Remote Advanced Payload Test Rig hardware, is shipped from MSFC to a specific payload location and is used to perform development and pre-flight software testing.

Marshall's custom-designed MSRR subsystems enable users to conduct high-temperature materials experiments on ISS.

Integrating SLS's Secondary Payloads onto EM-1

With Exploration Mission-1, SLS will carry not only Orion but also will transport the first CubeSats to deep space where they can be deployed and journey to destinations such as the moon and asteroids to gather data valuable to future exploration missions.

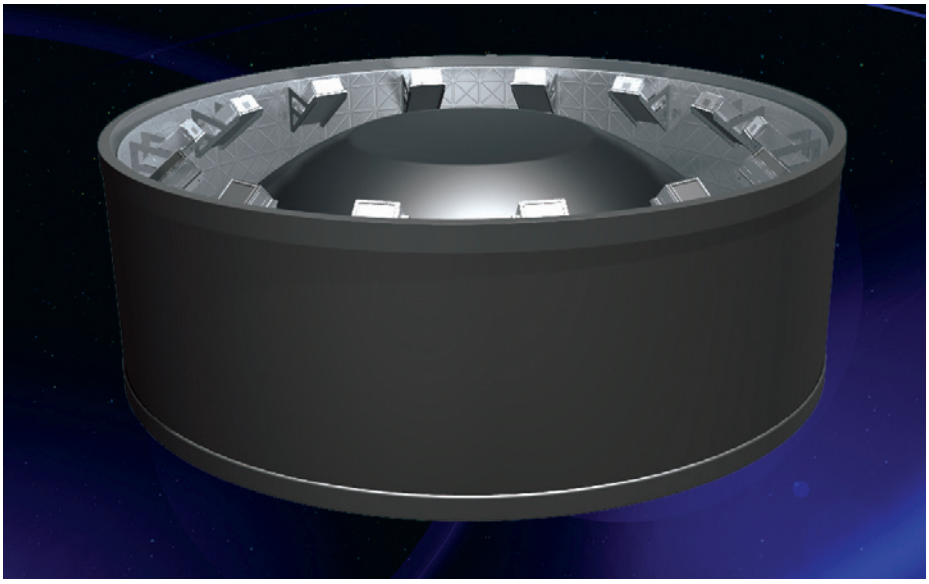
These secondary payloads, about the size of a large shoebox, will be housed in the multi-vehicle stage adapter, the ring that connects Orion's service module to the top stage of SLS. After Orion and the service module disconnect and continue on to orbit the moon, the secondary payloads deploy from the SLS stage adaptor and embark on their individual missions.

NASA selected the 13 secondary payloads based on their ability to address agency strategic knowledge gaps, providing key information to reduce risk, increase effectiveness and improve the design of robotic and human space exploration missions.

Marshall engineers developed payload integration components, including the avionics box, and the ancillary hardware that houses each payload. These capabilities allow designers to steadily move forward with development of the SLS and prove the systems' ability to carry and deploy experiments yielding invaluable science results on EM-1, and proving the feasibility of similar experiments and payloads on future SLS launches.

Among the 13 payloads selected, Marshall is home to the Near Earth Asteroid Scout. NEA Scout will utilize a large solar sail to navigate to and characterize an asteroid. Marshall engineers are also providing in-space propulsion support to JPL, who is developing Lunar Flashlight. This payload will travel to the southern poles of the moon and scan the dark crevices of craters for signs of water.

These will be the first CubeSats deployed in deep space where they can gather valuable data that will benefit future exploration missions.



Artist concept of the Orion stage adapter with secondary payloads and avionics box to control payload deployment

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