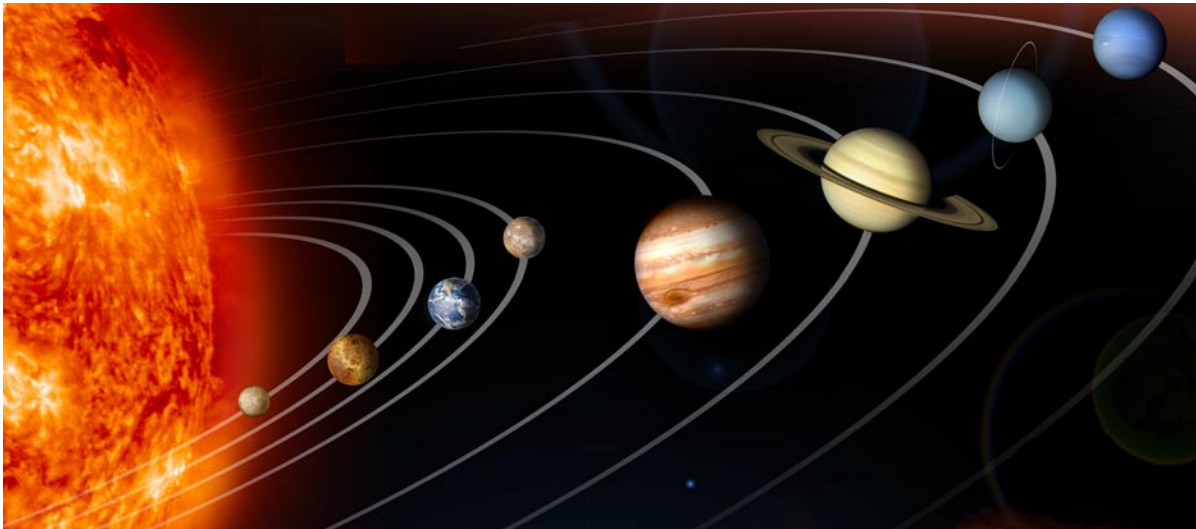


## NASA's Marshall Center Has Major Role in Current and Future Space Exploration



The Marshall Space Flight Center in Huntsville, Ala., is a key contributor to significant NASA programs, continuing a legacy of accomplishment that includes the Saturn V rocket that launched America's astronauts to the moon; Skylab, the world's first space station; the propulsion system for the space shuttle; Spacelab; the Hubble Space Telescope; and the construction and operation of the International Space Station. The Marshall Center currently has an important role in meeting NASA's exploration mission objectives, leading development of a new family of launch vehicles and a lunar landing mission.

The Marshall Center is NASA's designated developer and integrator of launch systems and a premier developer and integrator of space systems for science and exploration, having the engineering capabilities to take hardware from preliminary design to operation in space and extensive experience in both scientific and human spaceflight.

Marshall is one of NASA's largest field centers, occupying more than 1,800 acres on Redstone Arsenal. The center employs approximately 8,600 people, approximately 2,600 civil service and 6,000 contractor employees, with an annual budget of approximately \$2.6 billion.

As NASA looks to the future of space exploration, the men and women of the Marshall Center are focused on the Vision for Space Exploration. This Vision calls for the completion of the International Space Station and more ambitious human and robotic exploration of the moon, Mars and destinations throughout our vast solar system.

### Launch Vehicle Development

The future of space travel is evolving, and the Marshall Center plays a major role in maturing and delivering the systems needed for the next generation of space launch vehicles and propulsion.

NASA's Constellation Program includes a new family of launch vehicles to carry astronauts and cargo to the moon and as a stepping stone to human exploration of the surface of Mars and destinations beyond. The Exploration Launch Projects Office at Marshall is responsible for development and overall integration of Ares I, the crew launch vehicle that will transport the Orion crew exploration vehicle into space and deliver un-crewed cargo payloads to space. This includes leading propulsion design, development, systems engineering, full integration of elements, and safety and mission assurance activities.

**NASAfacts**

The Exploration Launch Projects Office also is responsible for near-term planning and future development of NASA's follow-on heavy-lift cargo launch vehicle and Earth departure stage, needed to leave Earth's orbit to travel to the moon and beyond. Ares V will carry heavy-lift payloads – from large-scale hardware and materials to food, fresh water and other staples – to space for use by exploration missions on the moon and destinations beyond.

### **Space Shuttle Propulsion**

The Space Shuttle Propulsion Office at the Marshall Center is responsible for the design, development, testing and flight performance of the space shuttle's external tank, main engines and solid rocket boosters with their reusable solid rocket motors.

The external tank continues to be at the heart of NASA's efforts for safe flight of the space shuttle. Safety-enhancing modifications are being made to reduce the risk of insulating foam and ice debris coming off the tank during launch and the climb to orbit.

The 154-foot-tall, 27.5-foot-diameter external tank is the largest single piece of the space shuttle vehicle. Loaded with liquid oxygen and liquid hydrogen propellants, it weighs more than 1.7 million pounds and is covered with insulating foam to keep the super-cold propellants cold. Yet, its aluminum-alloy skin is only a tenth-of-an-inch thick in most places.

The Marshall Center designed and has continued to improve the space shuttle main engines. The high performance, liquid propellant rocket engines are clustered at the aft, or tail, of the orbiter and have a combined thrust of more than 1.2 million pounds. The three, 14-foot-long main engines are the world's first reusable and most sophisticated rocket engines.

The space shuttle's two solid rocket boosters also are managed by Marshall's Space Shuttle Propulsion Office. The boosters provide 80 percent of the thrust for the shuttle's first two minutes of flight – some 5.3 million pounds. Each booster is 149.2 feet long and weighs approximately 1.3 million pounds when fueled for launch. Each holds four solid rocket motor segments and is filled with approximately 1.1 million pounds of solid propellant. The reusable solid rocket motors are the largest ever to fly and the only solid rocket motors used for human flight. After launch, the solid rocket boosters are recovered from the Atlantic Ocean, refurbished and reused.

### **International Space Station Support**

The International Space Station – the largest and most complex international scientific project in history – continues its orbit of the Earth every 90 minutes with an American astronaut and Russian cosmonaut on board. The Marshall Center has an important role in space station hardware development and science operations.

Marshall coordinates the day-to-day technical activities necessary for integration of Node 2 and Node 3 into the space station. These connectors between space station modules will be delivered on future shuttle missions. Marshall also is responsible for the design, construction and testing of station Express Racks, which support science payloads by providing experiments with utilities such as power, data, cooling, fluids and gasses, and of environmental controls and life support systems, including water recovery, electrical power, thermal controls and air processing. Marshall also manages the Multipurpose Logistics Modules – “moving vans” built by the Italian Space Agency to carry laboratory racks filled with equipment, experiments and supplies to and from the station.

The Payload Operations Center at Marshall is NASA's primary space station science command post, co-ordinating all U.S. scientific and commercial experiments on the station, as well as Earth-to-station science communications – 24 hours a day, every day of the year. The Marshall Center is responsible for training space station crew and ground controllers to operate and maintain U.S. science experiments.

### **Exploring the Solar System**

The Marshall Center has been asked by NASA Headquarters to play a significant role in the agency's exploration effort that will take astronauts to the moon, Mars and beyond.

Marshall has been selected to lead the Lunar Precursor and Robotic Program — an effort that will pave the way back to the moon. The office will manage projects and direct studies on lunar robotic precursor activities across NASA.

A new Lunar Lander Project Office also will be established at Marshall, reporting to the Constellation Program Office. This office will be responsible for performing early trade studies and developing requirements for the Lunar Surface Access Module, the capsule that will transport crew members to and from the surface of the moon.

In 2004, the Marshall Center was selected as the site of NASA's Discovery and New Frontiers Program Office. The program gives the science community an opportunity to propose full investigations to be conducted as a way to launch exploration missions in the solar system. Examples of program science missions include landing on an asteroid, a flight to investigate Mercury, capturing the essence of a comet and studying the structure of solar energy. Missions are led by NASA's Jet Propulsion Laboratory in Pasadena, Calif.; NASA's Ames Research Center in Moffett Field, Calif.; and Johns Hopkins University in Baltimore, Md.

### **Continuing Scientific Research and Discovery**

Marshall is conducting research into the scientific mysteries of the Earth and our solar system. Earth science researchers use advanced technologies to

observe and understand the Earth's global water cycle, as it relates to global and regional climate. Space scientists also conduct astrophysics and astrobiology research to support exploration of the cosmos.

NASA's Chandra X-ray Observatory, launched in 1999, continues its mission of discovery. The Marshall Center – which was responsible for the observatory's design, development and construction – manages Chandra operation and science activities. More than six years after launch, the world's most powerful X-ray telescope continues to rewrite textbooks with discoveries about our own solar systems and images of celestial objects as far as billions of light years away.

The Gravity Probe B mission is another program developed and managed by the Marshall team. Launched in 2004 to test Einstein's general theory of relativity, the mission contained the world's most precise gyroscopes housed in a satellite orbiting 400 miles above Earth's poles. By checking tiny changes in the direction of spin of the gyroscopes, the experiment measured how space and time are warped by Earth's presence. The collection of scientific data was completed in 2005, and results are expected to be announced in 2007.

### **Advanced Propulsion**

The Marshall Center also plays a significant role in maturing and developing advanced propulsion technologies to support NASA's future exploration goals.

To carry out this work, Marshall opened a state-of-the-art propulsion research facility in 2004. The Propulsion Research Laboratory is home to engineers and scientists who are pursuing technologies that will dramatically increase our ability to safely and routinely work and travel beyond Earth orbit. The laboratory is a national resource for researchers from NASA, other government agencies and universities to conduct short-and long-term experiments.

The Marshall Center also is working on in-space propulsion technologies – from advanced combinations of chemical fuels and propellants to systems that use the sun for propulsion or leverage a planet's atmosphere for braking to electric propulsion technologies. These propulsion concepts could significantly reduce cost, the size of spacecraft or travel times, enabling or benefiting more ambitious NASA space science missions between planets – and to the edges of our solar system.

### **Optics and Exploration Technology**

The Space Optics Manufacturing Technology Center at Marshall develops ultra-lightweight optics materials and fabrication technologies, and manages state-of-the-art test facilities for NASA. The center is testing new, advanced optics technologies for future space observatories to replace the Hubble Space Telescope and the Chandra Observatory.

Marshall engineers and scientists also are developing concepts and technologies to support further exploration of the solar system. Research teams are investigating technologies to use on-site resources of moons and planets for construction of habitats and energy sources, as well as to fabricate special-purpose tools and materials during long-duration spaceflight. Researchers also are pursuing new, resilient materials for shielding astronauts from radiation and portable tools to quickly identify biological organisms.

### **National Space Science and Technology Center**

The National Space Science and Technology Center in Huntsville is a collaborative research and education organization founded by the Marshall Center and the Alabama Space Science and Technology Alliance, a consortium of Alabama research universities. Here, NASA and university researchers conduct cutting-edge investigations in Earth and space science, optics, information technology and advanced propulsion technologies. Marshall provides science expertise to the center, and partners with it to foster education of the next generation of American mathematicians, scientists and engineers.

The exploration of the cosmos requires cutting-edge research in solar physics, advanced propulsion systems, next-generation optics and high-tech information retrieval, transfer and storage systems. Marshall science and technology researchers support a broad range of studies that will enable future space pioneers to live and work comfortably and safely as they venture away from Earth.

### **Engineering the Future**

Delivering highly skilled crosscutting engineering services to Marshall programs and projects, the Engineering Directorate is the backbone to mission success at the Marshall Center.

The directorate oversees Marshall's research and development capability for accomplishing engineering functions associated with the design, development, testing, operations and evaluation of its projects.

The Engineering Directorate provides integrated products and engineering services to NASA, other government agencies and the commercial space development community.

Engineering and analysis is conducted on systems related to space vehicles, payloads and support equipment, such as electrical systems, guidance and control systems and computer software and simulation systems.

The center's capabilities include integrated modeling and simulation; developing, testing and integrating launch vehicle systems; developing propulsion systems and components; developing propellant management, storage and delivery systems; and

designing automated rendezvous and capture systems. With these capabilities, Marshall is poised to support a broad range of space programs.

The directorate is comprised of three departments and three laboratories. The departments develop products for science investigations, conduct verification and integration of state-of-the-art spacecraft and vehicle systems and research and develop propulsion elements for space transportation systems, including the space shuttle and the Ares I crew launch vehicle.

The Instrument and Payload Systems Department designs, develops, assembles, integrates, tests and delivers flight, ground, prototype and development products for human spaceflight programs, science investigations and exploration initiatives. The Spacecraft and Vehicle Systems Department plans, performs and executes the research, development, design, evaluation, verification and integration of the state-of-the-art spacecraft and vehicle systems for the shuttle, International Space Station and exploration missions. The Propulsion Systems Department plans, directs and executes applied research, technology maturation, advanced design and development in support of engineering capabilities for NASA's space transportation systems for the Vision, as well as space shuttle propulsion elements and other Earth-to-orbit and in-space propulsion systems.

The Materials and Processes Laboratory provides research, technology and engineering support in materials, processes and products to be used in space exploration and manufacturing; and performs materials diagnostics and failure analysis for NASA and other customers. The Test Laboratory manages the functions, resources, services and facilities necessary for simulation of aerospace environments and flight-like conditions; and performs research, development, qualification and acceptance testing of flight and non-flight aerospace hardware. The Mission Operations Laboratory performs operations concept development, analyzes and develops requirements for flight and ground systems and manages ground and flight operations, including day-to-day science operations on the International Space Station.

The Engineering Directorate implements technical excellence as defined by NASA's Office of the Chief Engineer in Washington, providing a path separate and independent of the projects to elevate issues. The organization partners with project teams across NASA to ensure safe, reliable operations for every flight program.

### **Education Initiatives**

Marshall conducts education programs to inspire the next generation of explorers, including the Great Moonbuggy Race in which student teams design, build and race a human-powered moonbuggy. In the Student Launch Initiative, students design, build and launch rockets complete with scientific payloads. These and other initiatives enable students from elementary school through college to apply their learning to science and engineering projects.

### **More About NASA**

NASA has a rich history of unique scientific and technological achievements in human spaceflight, aeronautics, space science and space applications. NASA searches for answers and asks new questions. It blazes new trails through space to tell others about the challenges, the adventure and the knowledge gained. That knowledge accelerates innovation with a return investment that includes further exploration and a better understanding of our solar system, and improvements to everyday life on Earth: all part of NASA's exploration goals.

The Marshall Center pursues the agency's mission by routinely partnering with and supporting the work of the other NASA field centers. The Marshall Center also works closely with the U.S. Department of Defense, the Department of Energy and other government agencies, and with leading academic institutions and industry partners around the world.

For more information about the Marshall Center, visit:

<http://www.nasa.gov/centers/marshall/home/index.html>