NASA Facts

National Aeronautics and
Space Administration

Marshall Space Flight Center
Huntsville, Alabama 35812

FS-2001-03-69-MSFC

August 2001

The National Space Science and Technology Center

…A partnership for research

A partnership between NASA's Marshall Space Flight Center in Huntsville, Ala., Alabama universities, federal agencies and industry, the National Space Science and Technology Center—with its core facility is in Huntsville—is a laboratory for cutting-edge research in selected scientific and engineering disciplines.

Imagine a place where researchers and educators could share facilities and ideas—a place for pooling talent and resources in pursuit of new knowledge, breakthroughs that range from shedding new light on the structure and evolution of the universe to better understanding Earth's weather.

That place is the National Space Science and Technology Center (NSSTC) a research organization with its core facility in Huntsville, Ala. A partnership between NASA's Marshall Space Flight Center in Huntsville, Alabama universities, federal agencies and industry, the Center is a laboratory for cutting-edge research in selected scientific and engineering disciplines.

Solutions to science and technology problems sometimes require knowledge from multiple fields of expertise. This also holds true for many technologies, which involve devices and supporting analyses across several engineering fields. That is why one of the NSSTC's objectives is to promote interdisciplinary research and development, achieving a synergy among multiple specialties.

The Center, opened in August 2000, focuses on space science, Earth sciences, information technology, optics and energy technology, space propulsion science and technology, biotechnology, materials science, and supports NASA's mission of advancing and communicating scientific knowledge, using the environment of space for research.

Not only does the NSSTC enable cutting-edge basic and applied research, it also fosters the education of the next generation of scientists and engineers. Undergraduate and graduate students participate in the cooperative research and experience is provided for educators.

Research performed by the National Space Science and Technology Center ranges from pure science to technology development—with spacecraft, sounding rockets, balloons and aircraft, as well as laboratory experiments being used to perform this research.

The NSSTC was formed between NASA and the State of Alabama through the Space Science and Technology Alliance—a group of six research universities, including the University of Alabama in Huntsville; Alabama A&M University in Huntsville; Auburn University in Auburn; the University of Alabama at Tuscaloosa; the University of Alabama at Birmingham; and the University of South Alabama in Mobile.

Science Research Centers

Research at the National Space Science and Technology Center is implemented through seven research Centers, which operate from the core facility in Huntsville, as well as at NASA's Marshall Center and the participating universities. The seven research Centers include:

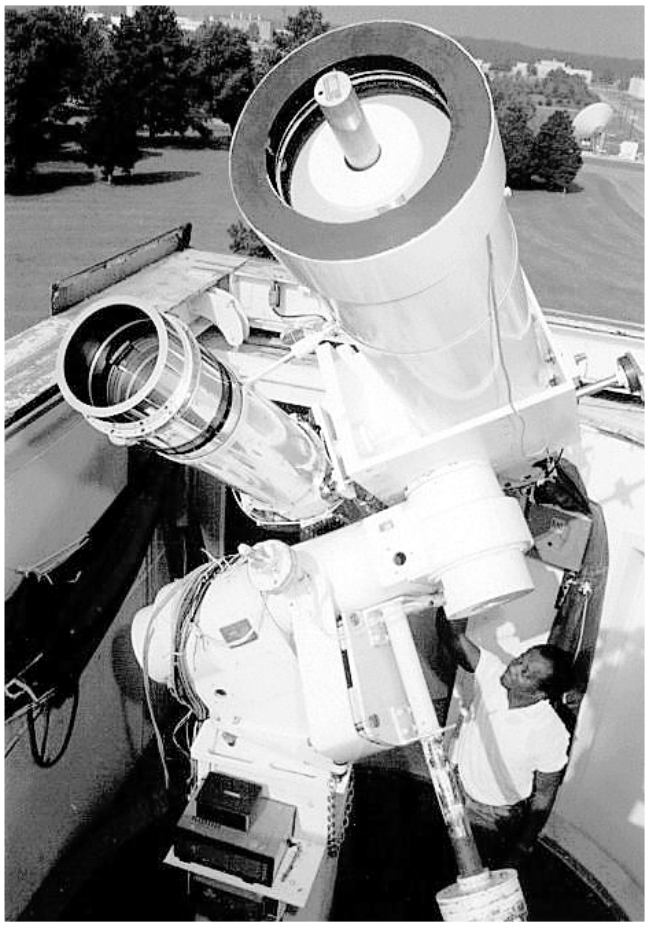
- Space Science Research Center
- Global Hydrology and Climate Center
- Information Technology Research Center
- Optics and Energy Technology Center
- Propulsion Research Center
- Biotechnology Research Center
- Materials Science Research Center

Space Science Research Center

The Space Science Research Center conducts investigations in physics and astronomy in support of NASA's Office of Space Science (Code S). The Center's primary activities fall within two Code S themes—the Sun-Earth Connection (solar physics, space plasma physics) and the Structure and Evolution of the Universe (Gamma Ray Astronomy, X-ray Astronomy, Cosmic Ray Astrophysics).

The emphasis in solar physics is on the measurement of magnetic fields and how magnetic energy fuels coronal mass ejections and other explosive events. These events perturb the near Earth space environment, which is the area of study of the Space Plasma Group. The astrophysics groups study the physical characteristics of exotic astronomical objects including gamma ray bursts, pulsars and black holes. Secondary

activities in planetary atmospheres and studies of terrestrial life in extreme environments support the Origins theme.



Other government organizations which participate in, or benefit from, the Center's research include the National Oceanic and Atmospheric Administration, Department of Defense, National Science Foundation, and Department of Energy.

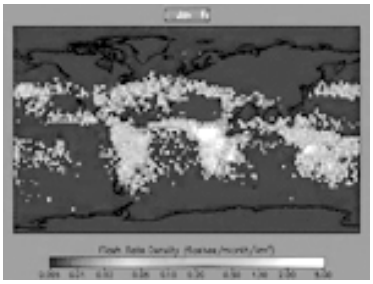
The National Space Science and Technology Center's Space Science Research Center conducts investigations in high-energy astrophysics, space plasma physics, astrobiology and solar physics—research that requires specialized equipment, including the Solar Vector Magnetograph, left, located at NASA's Marshall Space Flight Center. By measuring the magnetic field on the Sun, this facility helps predict solar flares and other solar activity. NSSTC scientists use this observatory, as well as space-based instruments, to gain understanding of the geospace environment and violent events occurring in the universe.

Global Hydrology and Climate Center

As its name implies, the Global Hydrology and Climate Center conducts research in the global hydrology and climate science disciplines. Its primary objective is to understand the Earth's global water cycle, the distribution and variability of atmospheric water, and the impact of human activity as it relates to global and regional climate.

Major research areas include winds and dynamics in the troposphere, the atmospheric layer closest to our planet; lightning and severe storms; water vapor, aerosol and temperature measurements; climate variability monitoring; climate modeling; atmospheric chemistry; land use change; impacts of urbanization on the climate and environment; and remote sensing, which uses aircraft or orbiting satellites to gather information on conditions ranging from air temperature to frequency of lightning.

Building on its research, the Global Hydrology and Climate Center supports educational efforts and works with other organizations to offer real-world solutions to research problems. The Center's scientists have worked with some of the nation's largest cities to combat the "urban heat island" effect—a phenomenon of urban areas becoming much hotter during the day than surrounding rural or vegetated areas.



Lightning and severe storms are among the numerous climate-related areas being studied by scientists at the NSSTC's Global Hydrology and Climate Center. Some of its scientific research has focused on the annual cycle of lightning patterns around the planet.

Benefiting from Global Hydrology and Climate Center research are NASA's Office of Earth Science, the Environmental Protection Agency, National Oceanic and Atmospheric Administration and National Science Foundation.

Information Technology Research Center

The Information Technology Research Center performs research and development in innovative methods for accessing, processing, storing, and transferring scientific data, as well as addressing high-performance networking issues.

The NSSTC's Global Hydrology and Climate Center has already realized success in offering real-world solutions to a challenge impacting millions of Americans—the "urban heat island" effect. This is the phenomenon of urban areas becoming much hotter during the day than surrounding rural or vegetated areas. Thermal images, like this one of downtown Baton Rouge, La., are being used to improve tree-planting programs in the city.

Working to develop new computational techniques and systems that ultimately solve real-world problems, this group is instrumental in working collaboratively on scientific breakthroughs in multiple disciplines.

Scientists of the Information Technology Research Center are involved in research in:

- technologies and methods for high-performance networking;
- data mining and knowledge discovery, the automated extraction of information;
- architectures and applications for high-end computing;
- image processing and pattern recognition;
- software engineering;
- and distributed information systems and knowledge environments.

Optics and Energy Technology Center

The Advanced Optics and Energy Technology Center is developing new technology for space and ground telescopes, energy delivery, and advanced materials. Activities span fundamental research on breakthrough propulsion and laser physics to the formulation of international missions to the Space Station.

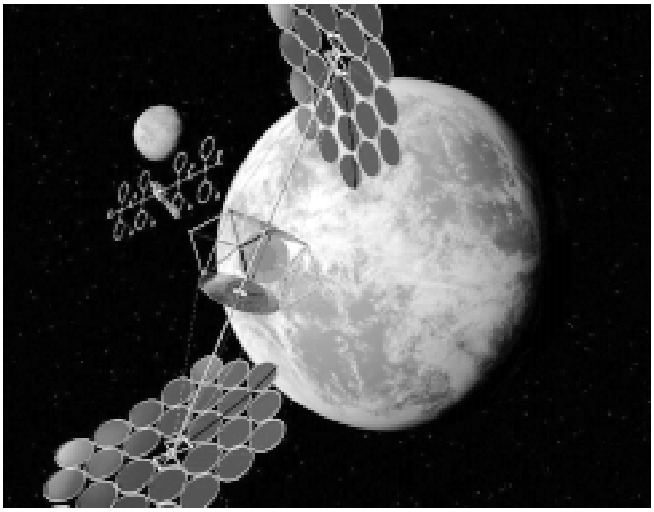
Researchers and engineers at the Optics and Energy Technology Center focus on advanced research and development in the fields of analysis, design, fabrication, testing and integration of ultra-high precision optical components and systems.

Research goals include the development of very large mirrors and lenses for incredibly lightweight gossamer systems in space as well as robust hardware for astronomical observatories in remote locations on the earth.

Other research includes methods of generating efficient, clean, safe, and economical methods of transmitting energy from locations of abundance (solar energy in space, hydroelectric dams, remotely located power plants, etc.) to places of critical need which are currently undeveloped because of inaccessibility to power.

Other areas of research include special materials. Fiber optics research is leading to better systems for lightweight, compact, efficient systems for high-speed communications and other applications in the information technology world. Other material systems are being investigated to make better lasers, and research is being supported in the development of hollow carbon fibers. Research into the applications of new materials is going on including the new field of tensegrity design, a method of building large structures using wires, rather than columns, for support.

Optics and Energy scientists and engineers support other NSSTC groups, academia, NASA Centers, government agencies and industry customers.



The NSSTC's Advanced Optics and Energy Technology Center is developing new technology for space and ground telescopes, advanced materials and energy delivery. This concept represents a space-based power generator designed to harvest energy from the Sun for use back on Earth.

Propulsion Research Center

Investigators in the Propulsion Research Center are working to discover and develop new, revolutionary methods of propelling spacecraft. The breadth of activities is extensive and ranges from providing improvements to existing propulsion systems to resolving the scientific issues associated with the advanced, high-payoff propulsion concepts of the future. Core activities are divided up into the five areas of advanced chemical propulsion, advanced combined rocket/air-breathing engine cycles, high-energy electromagnetic and plasma propulsion, nuclear propulsion, and propellantless propulsion.

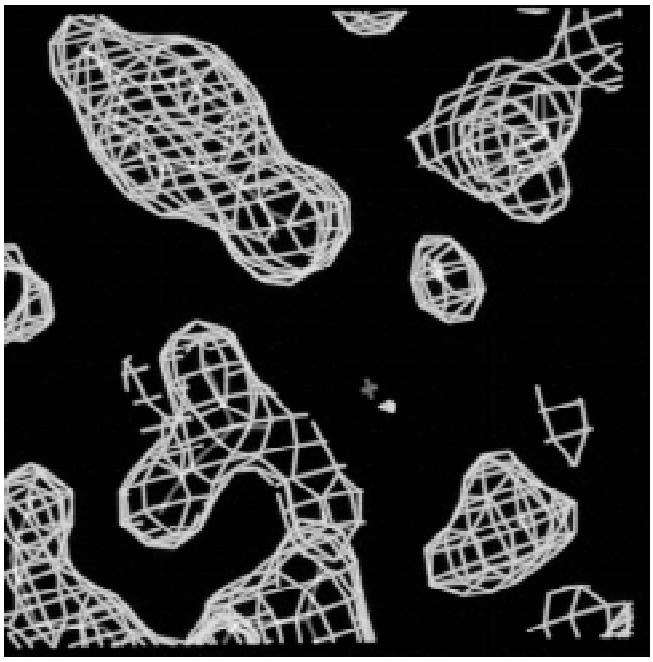
All of these areas have the potential for meeting NASA's most ambitious goals in earth-to-orbit and in-space transportation. They could also open new avenues for commercialization of space, in addition to providing fruitful spin-offs to commercial power, medicine and other fields.

Teams of NSSTC researchers—from NASA, universities and the private sector—are working to achieve these goals through fundamental scientific investigations and proof-of-principle demonstrations of the advanced propulsion technologies needed for the future. Their work adds to the present-day knowledge of physics, as well as to the research's potential application to space flight. In addition to supporting NASA's Advanced Space Transportation Program, the Propulsion Physics Research Center works with various advanced technology programs sponsored by the U.S. government.

Investigators in the Propulsion Research Center are working to discover and develop new, revolutionary methods of propelling spacecraft, including air-breathing rocket vehicles—one of several concepts with the potential to meet NASA's most ambitious goals in Earth-to-orbit and in-space transportation.

Biotechnology Research Center

The Biotechnology Research Center pursues the goals of "Science in the National Interest"—a federal policy calling for science as a national priority—by researching biotechnology. The Center's goals are to increase our knowledge of nature's processes using the space environment as a novel tool of research, to engage and advance the rapidly advancing frontiers of biotechnology on Earth in order to maximize benefits to the manned space program, and to enrich life on Earth through knowledge gained in biotechnology applications by people living and working in space.



The scientists and engineers of the NSSTC's Biotechnology Research Center, working with NASA and industrial scientists, conduct research in selected areas of biotechnology, including macromolecular crystallography, a technique to determine a molecule's three-dimensional structure. Like many chemicals in the body, the three-dimensional structure of insulin is extremely complex. When grown on the ground, insulin crystals do not grow as large or as ordered as researchers desire—obscuring the blueprint of the insulin molecules.

Research often supports NASA's Human Exploration and Development of Space Enterprise (HEDS), which manages and implements NASA's life sciences objectives.

The scientists and engineers of the Biotechnology Research Center, working with NASA and industrial scientists, conduct research in selected areas of biotechnology, including:

- applications of both cells and macromolecules as biomarkers, as biosensors, and as methods of therapeutic intervention;
- structural and functional genomics—the study of genes that includes use of DNA sequences for research applications, gene management for expression of macromolecules, and the biochemical determination and control of gene function;
- isolation and investigation of extremophiles—organisms that live under extreme conditions;
- macromolecular crystallography, a technique to determine a molecule's three-dimensional structure;
- macromolecular areas of nanotechnology, the process of constructing tools at the molecular level.

The Biotechnology Research Center obtains new knowledge in biological and chemical systems that may be applied to commercially viable products and processes. Groups that may benefit from its research, in addition to NASA, include the national research community, academia, industry and government. Biotechnology research is a component of NASA's Microgravity Program within the NASA Marshall Space Flight Center.

Materials Science Research Center

The Materials Science Research Center pursues basic research in all areas of materials science. One of the Center's goals is to sponsor studies, which will lay the foundation for further developments that will help enable NASA missions. By providing the foundation for future materials development for the agency, and in consideration of the far-reaching applications space-related material developments continue to demonstrate, the activities of the Materials Science Research Center will benefit the space agency, the nation and people throughout the world.

The Center both complements and is synergistic to the NASA's Microgravity Program, the initiative that conducts research in the low-gravity environment of space. Ground-based experiments will uncover areas that require further investigations in a gravity-free environment, while other studies will enable

scientific phenomena, observed in a microgravity environment, to be translated into rules and principles that can be applied in a ground-based process.

Potential areas of research include:

- nanomaterials science, which seeks knowledge and tools for building structures atom by atom;
- polymer films development;
- aerogels, ultra-lightweight materials with applications ranging from optics to thermal and acoustic insulation;
- lightweight superconductors, necessary for generating high-strength magnetic fields required for in-space propulsion;
- environmentally friendly materials development;
- sealant materials science, seeking sealants that can withstand high-strain environments;
- environmental reactions of ceramics, ceramic matrix composites, and metallic materials, seeking a better understanding of the effects of oxygen, hydrogen and steam;
- modeling software for advanced materials and processes;
- modeling in microgravity science;
- ceramic and glass processing by sol-gel ceramic synthesis, a technique that offers composition and structure control at the molecular level;
- radiation shielding space materials;
- in-space manufacturing techniques;
- electronic and optical materials development for the hostile environment of space;
- electronic materials science in microgravity;
- biomimetic materials science, the development of artificial materials and structures based on information from biological systems.

The Impact of Technology Development

At the National Space Science and Technology Center, technology comes full circle: Technology is required to achieve scientific research. The development of this technology leads to capabilities for flight science missions. The flight science missions lead to new knowledge to fulfill the original quest. And, ultimately, the research indicates new directions of investigation.

The major objective of the National Space Science and Technology Center is to create a successful collaborative research environment that gains the Center recognition as a world-class organization for addressing selected science and engineering problems.