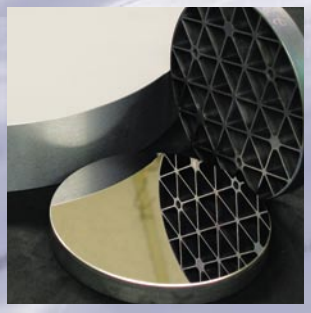
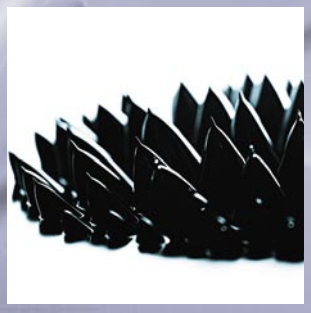
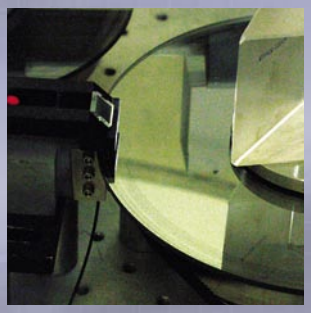
National Aeronautics and Space Administration

NASA Goddard Space Flight Center

Technology Transfer 2005







accomplishments

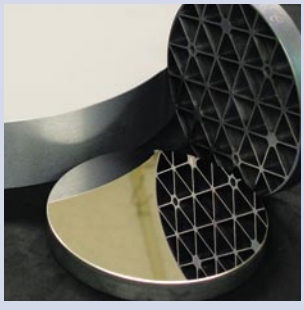
Pictured Goddard technologies

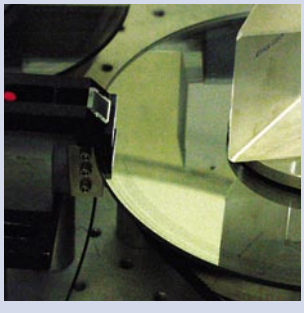
(top to bottom):

- Multipurpose Exoterrain for Robotic Studies
- Single-Crystal Silicon Mirror
- Submicron-Sized Pointed Structures
- Rotary Encoder

From the Chief

Looking Back, Looking Ahead





As NASA has moved another year closer toward the goals outlined in the *Vision for Space Exploration*, which President Bush put forth in early 2004, the Office of Technology Transfer at Goddard Space Flight Center is proud of its contributions toward that vision in fiscal year 2005.

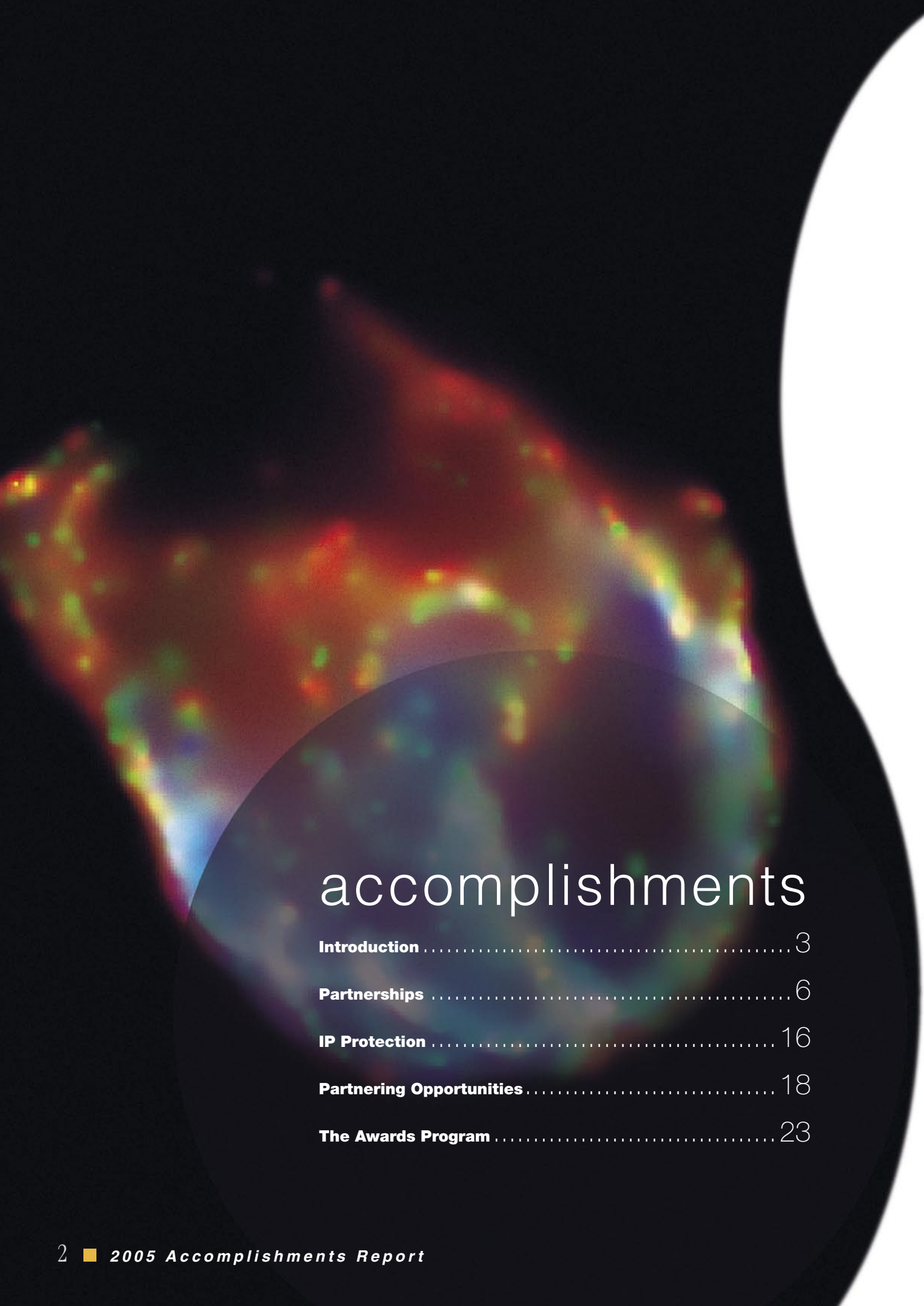
During the past year, OTT put several partnerships in place that are providing Goddard's researchers with access to new technologies and state-of-the-art facilities. These resources complement the cutting-edge capabilities and expertise already in place at Goddard. By sharing resources and combining our efforts, Goddard and our partners can accelerate their R&D to benefit NASA's missions—space exploration, science, aeronautics, and space operations—as well as Earth-based innovations. That is true partnership.

At the same time, OTT found commercial applications for Goddard's space-program technologies. These "spinoffs" are expected to benefit medicine and public health, commercial aviation, homeland security, the environment, and more. We also entered into several partnerships with universities that not only will benefit NASA but also will foster entrepreneurship and the next generation of scientists and engineers.

This report summarizes Goddard OTT's partnership successes as well as our other accomplishments for fiscal year 2005.

In 2006, our "partnership pipeline" is filled with promising opportunities for collaboration related to optics, electronics, information technology, smart materials, and more. I look forward to presenting those accomplishments to you next year.

Nona Minnifield Cheeks
Chief
Office of Technology Transfer
NASA Goddard Space Flight Center



accomplishments

introduction

WHAT WE DO

NASA Goddard Space Flight Center

Expanding knowledge of the Earth and its environment, the solar system, and the universe through observations from space.

Located in the Maryland suburbs of Washington, D.C., NASA Goddard Space Flight Center is the nation's largest organization of scientists and engineers dedicated to learning and sharing their knowledge of Earth and our sun, solar system, and universe.

Scientists at Goddard study land, sea, ice, and air to understand our changing climate. We use our satellites, technology, and know-how to understand and protect our home planet by learning more about it and how to take care of it. We also develop and support many missions that will reveal the secrets of our solar system.

Goddard's core competencies include:

- Experimental and theoretical science
- Sensors, instruments, and their associated technologies
- End-to-end mission system engineering
- Advanced flight and ground systems development
- Large-scale scientific information systems
- Program and project management

As NASA pursues the *Vision for Space Exploration*, Goddard is conducting research and development (R&D) in many areas, including:

- Electronics
- Guidance and navigation
- Information technology
- Optics
- Sensors

Technology Transfer

WHAT IT IS

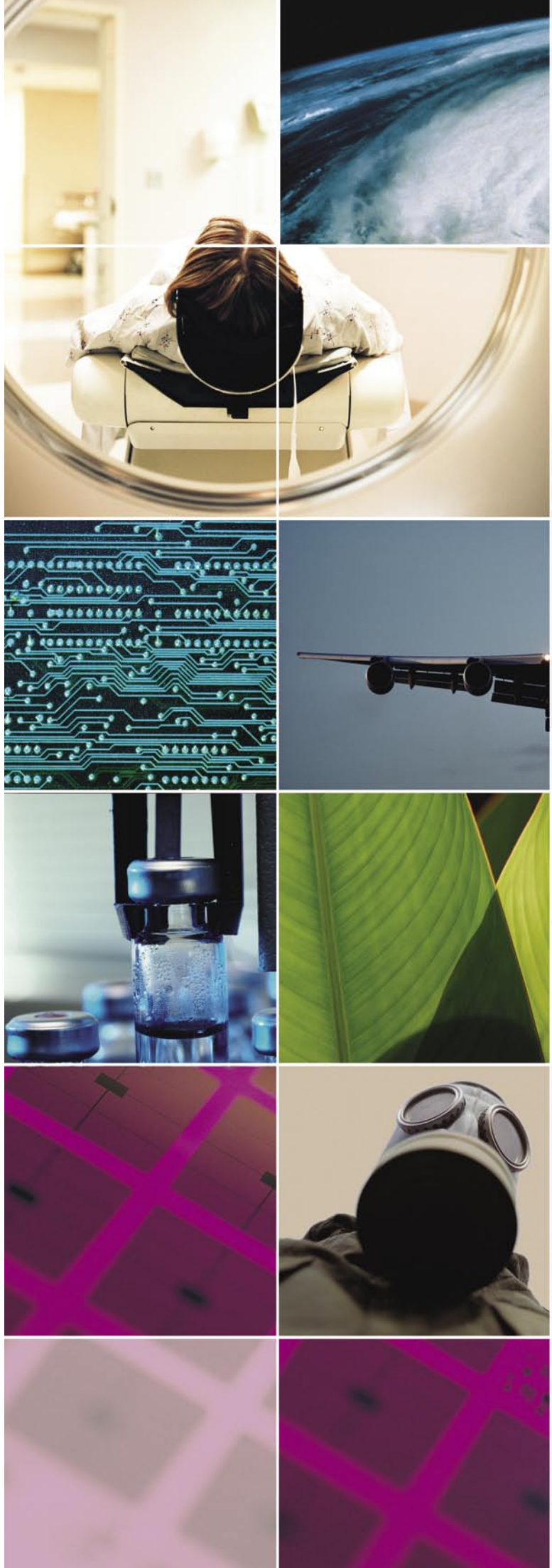
Creating new uses for an innovation—a device, a software program, a material, a process—originally developed for another purpose or application.

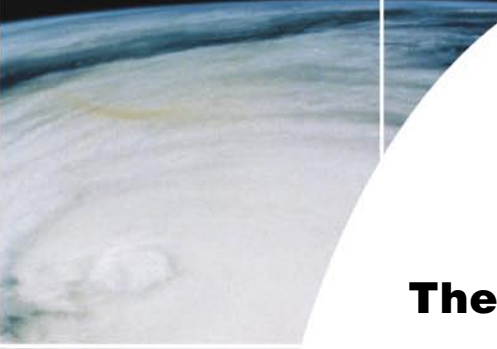
NASA's technology transfer efforts focus on achieving two specific goals:

- Forming partnerships with industry, academia, and other government agencies to support NASA programs
- Transferring space-program technology to new applications to enhance NASA's technology and commercial objectives

R&D at NASA has relevance to many Earth-based industries:

- Health and medicine
- Electronics, energy, and photonics
- Advanced materials and chemicals
- Transportation
- Environmental
- Homeland security
- Manufacturing
- Telecommunications
- Consumer products





The Benefits of Technology Transfer

Accelerating R&D advances inside and outside NASA and increasing the taxpayer's return on investment.

WHY TRANSFER TECHNOLOGY

Technology transfer has many benefits. For NASA, technology transfer:

- Accelerates the achievement of space exploration, science, and other mission goals, bringing us closer to understanding our universe and our home planet
- Leverages partner resources and generates royalty revenue for out-licensed space-program technologies, making NASA more efficient with its R&D funds
- Increases the benefits of the space program, yielding a greater return on the taxpayer's investment

But the benefits of technology transfer are not limited to NASA. Technology transfer also:

- Helps U.S. businesses be successful
- Improves quality of life and public health
- Increases U.S. economic development

Goddard's Office of Technology Transfer

Realizing the benefits of technology transfer for Goddard, for NASA, for our partners, and for the American people.

WHAT WE DO

The Office of Technology Transfer (OTT) at NASA Goddard Space Flight Center is tasked with seeking out and forming successful partnerships to meet NASA mission needs. To achieve this goal, OTT:

- Strategically evaluates Goddard's R&D needs as well as its new technologies
- Performs market-based analyses to determine areas of overlap between Goddard's needs and technologies and those of industry, academia, and other government agencies
- Identifies external innovations to accelerate solutions to meet Goddard's needs
- Finds new applications for Goddard-developed innovations
- Forms the partnership, licensing, and other agreements to effect technology transfer

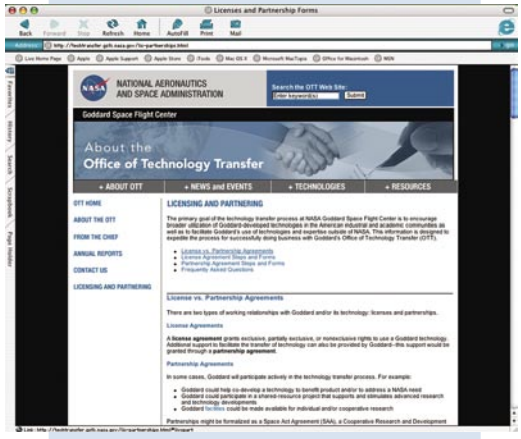
In performing these tasks, OTT utilizes best practices while innovating for efficient and effective solutions.

OTT's results for fiscal year 2005 are the accomplishments described in this report.

partnerships

What are partnerships?

Regardless of whether OTT is transferring an outside technology into Goddard to advance a NASA mission or finding new uses for a Goddard-developed technology, partnerships allow Goddard to work with other organizations. Once an agreement is in place, the exchange of technology, information, know-how, expertise, and equipment can take place while protecting the interests of Goddard and its partner.



On the Web

Goddard uses a variety of agreement vehicles to form successful partnerships, including Space Act Agreements (SAAs), Cooperative Research and Development Agreements (CRADAs), and license agreements. For more information about licenses and partnerships with NASA Goddard Space Flight Center, see http://techtransfer.gsfc.nasa.gov/lic-partnerships.html.

Why are they important?

Partnerships allow Goddard to use fewer resources to solve its technical challenges while providing many benefits to the partner organization, including:

- Access to Goddard's equipment and facilities
- Access to Goddard's innovative technologies
- Access to Goddard's technical expertise

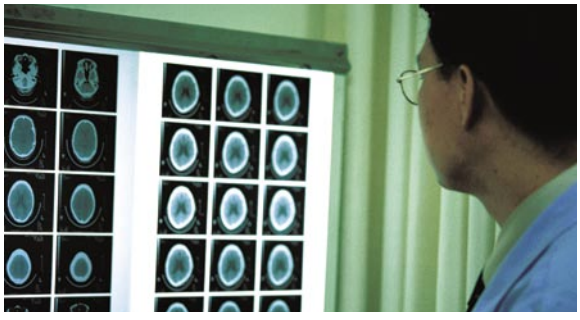
Our 2005 Accomplishments

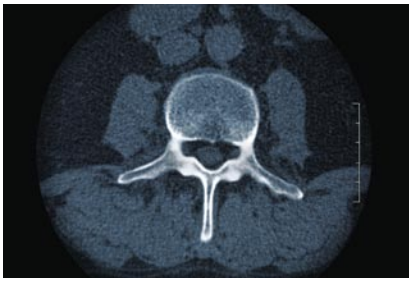
Advancing Drinking-Water Monitoring

In developing its BioSentry™ product line, JMAR Technologies, Inc., of San Diego, California, licensed NASA Goddard's Holographic Circle-to-Point Converter in 2005.

BioSentry is a real-time, online system for continuous monitoring of drinking water supplies for water utilities, bottled water and beverage processors, and homeland security. Goddard's technology is an optical device that reduces the cost, complexity, and size of lidar (or "laser radar") systems. Initially developed for use in direct-detection Doppler lidar systems, Goddard's technology also can be used for particle counting and contamination monitoring. JMAR experimented with that application.

Beta tests of BioSentry at a beverage facility used Goddard's technology, and the company has since made other advancements to its product. JMAR credits Goddard's technology with speeding up BioSentry's system architecture design, reducing the cost and complexity of entering the marketplace.





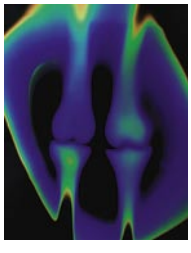
Improvements to Medical Imaging

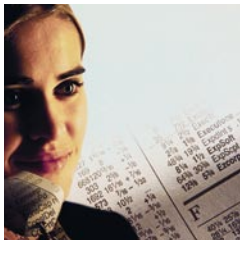
Bartron Medical Imaging of New Haven, Connecticut, entered an agreement for the development of a three-dimensional (3-D) version of Goddard's Recursive Hierarchical Segmentation Software (RHSEG), which was developed to rapidly analyze satellite image data.

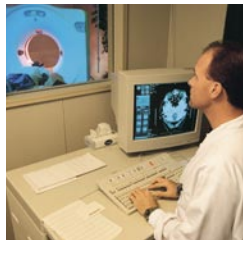
Currently, Bartron's Med-Seg™ imaging device utilizes a 2-D version of Goddard's RHSEG software to analyze digital X-rays, soft-tissue scans, mammograms, ultrasounds, MRI images, and CT scans. The RHSEG software allows Med-Seg to bring out image details that cannot be seen with the naked eye, enabling physicians to more quickly and accurately diagnose diseases and prescribe appropriate treatment—a benefit that not only can shorten pain and suffering but also can save lives.

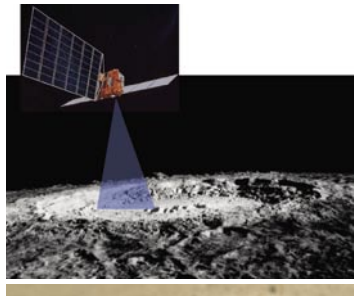
By extending the software's capabilities to three dimensions, Bartron's device may be able to produce a much finer detailed view of all sides of a tumor or lesion. Bartron President and CEO Fitz Walker said, "We believe this will drastically improve very early diagnosis and treatment of disease," including breast cancer, cervical cancer, brain cancer, heart disease, osteoporosis, and periodontal diseases.

Under the agreement, Goddard will develop the 3-D implementation of the software, while Bartron will develop the clinical and regulatory protocol as well as the interface for the software and hardware and other tools.







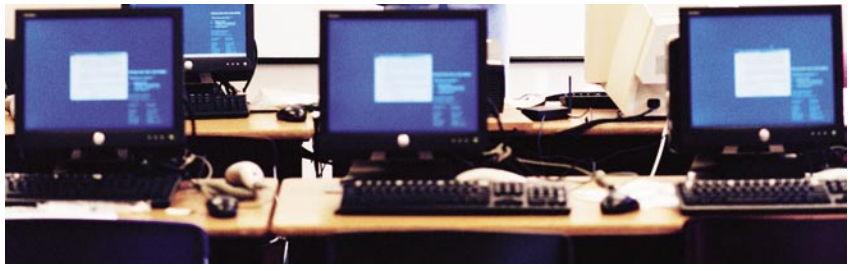


Increasing Efficiency of Image Processing

Researchers at Goddard and Universidad de Extremadura in Spain (UEX) are combining their expertise to improve hyperspectral imaging. The goal is to develop new algorithms that increase the efficiency of parallel processing of imaging data.

Under the partnership agreement, UEX has access to the algorithms in Goddard's RHSEG software—the same technology being accessed by Bartron Medical Imaging as described above—as well as remote access to Goddard's Beowulf PC clusters for parallel processing. Similarly, Goddard has access to UEX's hyperspectral scene data collected over various semiarid areas in Spain. UEX also is providing expertise and algorithms for additional analyses of imagery data.

Advances in Goddard's RHSEG software will further enhance its applicability to planetary exploration and terrain mapping.



Goddard Technologies ACTiVATE Maryland Entrepreneurs

Goddard technologies are being evaluated for their start-up potential by participants of the University of Maryland, Baltimore County's (UMBC's) unique ACTiVATE program. Launched in 2004, ACTiVATE—that is, Achieving the Commercialization of Technology in Ventures through Applied Training for Entrepreneurs—is designed to increase the commercialization of technology innovations from research institutions in Maryland by training mid-career women entrepreneurs to create technology-based start-up companies.

"Access to high-quality technology is critical to the success of the ACTiVATE program," said Stephen Auvil of UMBC's Office of Technology Development. "Through this key partnership with NASA Goddard, the ACTiVATE program will rely on NASA's valuable research and long tradition of innovation to provide such technologies."

The agreement with UMBC will also enable Goddard to obtain assessment data from UMBC to assist in future NASA technology transfer efforts. Or, if program participants see sufficient potential in a Goddard technology, they can license it as the foundation for a start-up company.

Goddard is the first government lab to participate in ACTiVATE and, according to Auvil, Goddard contributed more technologies than any other research institution in the state of Maryland during the program's first year. One of those technologies successfully moved from Phase I's opportunity analysis to Phase II's business plan development.

The coming year will see more Goddard technologies provided to the ACTiVATE program.

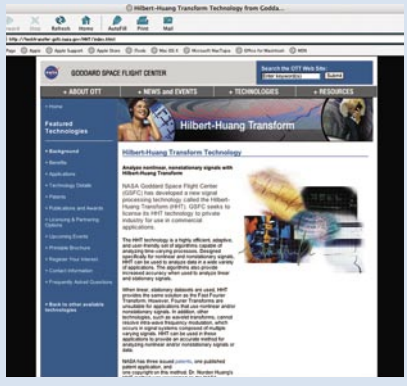
Two Partnerships for Signal Processing Technology

One of the most exciting innovations to come out of Goddard in recent years is the Hilbert Huang Transform (HHT) technology. Goddard's HHT technology is a highly efficient, adaptive, and user-friendly set of algorithms capable of analyzing data from processes that change over time, which is the case for most naturally occurring phenomena. As a result, the technology has a broad range of applications and has won many awards.

During FY05, OTT successfully negotiated two agreements related to the HTT technology:

- BCG Wireless, a small business located in Baltimore, Maryland, is working to apply Goddard's patented signal processing technology to radio frequency (RF) communications systems, networks and applications. BCG envisions exploiting this technology for RFID, wireless local and wide area networks, and other systems where radio interference is a significant issue.
- Goodrich Corporation is working to improve safety of commercial aircraft wiring systems as part of a project with the Federal Aviation Administration (FAA). As part of this effort, the company is studying the applicability of HHT to inspection, fault analysis, and diagnosis of various types of wires.

As part of these partnerships, Goddard is providing technical expertise on the HHT technology, with the companies reimbursing Goddard for this support. In addition, the technical advances made by these companies are expected to come back to NASA for use in space exploration and other programs.



On the Web

The Office of Technology Transfer maintains a Web site with detailed information about Goddard's Hilbert Huang Transform technology (http://techtransfer.gsfc.nasa.gov/HHT/index.html).

Other featured technologies available from Goddard also are listed online: http://techtransfer.gsfc.nasa.gov/technologies.html

Using SpaceWire to Reduce Space-Mission Development Time

A leading U.S. aerospace corporation is going to be working with Goddard researchers to better apply SpaceWire to its space-flight missions.

Developed in 1999 under the auspices of the European Space Agency, SpaceWire is a high-speed communications protocol for flight electronics. It provides a scaled down, simple design that can be used and reused, which saves development time and resources while giving system engineers plenty of flexibility to develop additional protocols.

Researchers at Goddard have developed a well-tested and well-verified design for SpaceWire. Under the partnership agreement, Goddard is providing that design to the company as well as helping the company develop new protocols that will enable customization for its own missions. In return, the company is reimbursing Goddard for this support and will provide Goddard access to the modifications, which will benefit future NASA missions.

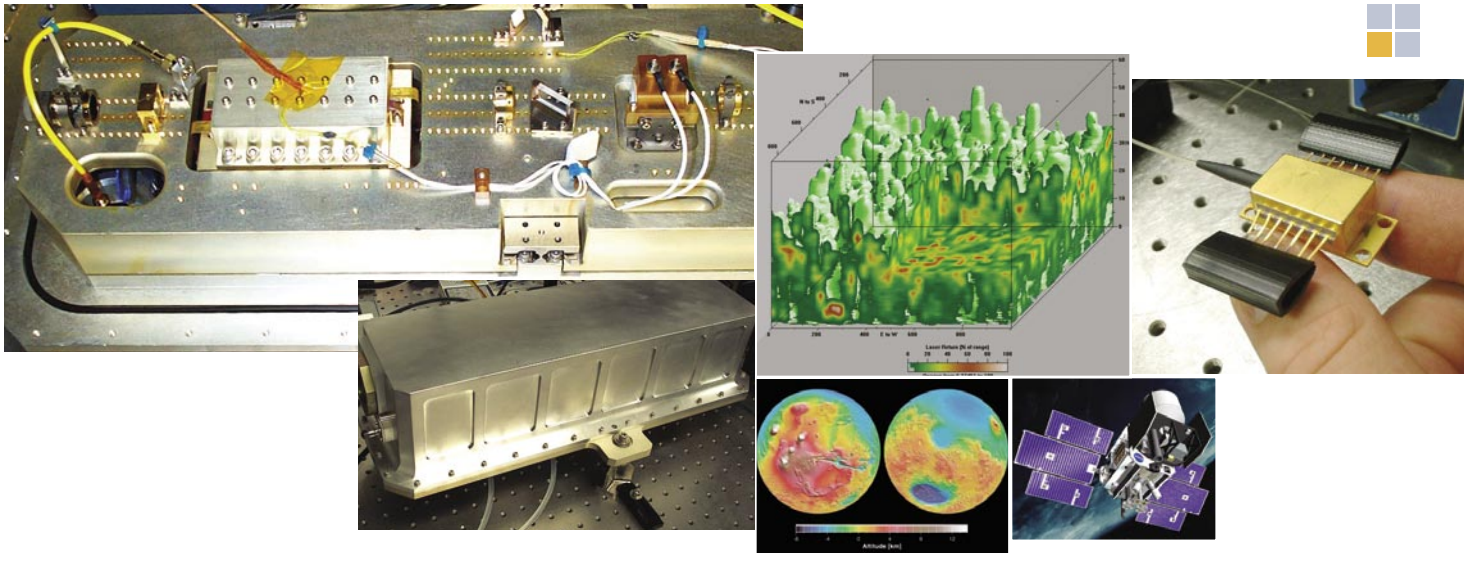
Testing Goddard's Gear Technology for the F-35

Eaton Aerospace, working as a subcontractor to Lockheed Martin, is participating in the development of the F-35 for the U.S. Defense Department. Part of this work involves supplying actuators to use in the state-of-the-art fighter jet. When Eaton realized that its actuator design was exceeding the jet's size and weight specifications, the company turned to Goddard for a solution.

Researchers at Goddard have developed an innovative gear bearing for possible use in positioning telescope mirrors or handheld tools used by astronauts. Incorporating this technology into Eaton's actuator might bring down the size and weight of the company's product, allowing it to come within the F-35's specifications.

Under the auspices of a Space Act Agreement signed in 2005, Eaton is designing, fabricating, and testing an actuator that incorporates Goddard's gear bearing technology. If it is successful, Goddard's technology will fly aboard the F-35.

In addition to the potential benefits to the F-35, NASA also stands to benefit from the agreement. Eaton's work will advance the technology readiness level (TRL) for Goddard's gear bearings as well as reduce NASA's costs for flight-qualifying the technology. TRL advances also will accelerate the use of gear bearings in NASA's many potential space-exploration applications (e.g., robotics, space tools, rovers).



A Partnership for Improved Lasers

In an effort to increase the stability, efficiency, robustness, and lifetime of lasers used in long-duration space missions while keeping costs down, Goddard is collaborating with AdvR to build a flight-qualified semiconductor seed laser.

Seed lasers provide a stable, single-frequency, low-power source that can greatly improve the total laser system's lifetime and improve the operational specifications. However, flight-qualified seed lasers have been very expensive, relatively inefficient, and large for such a low-power device. By working together, AdvR and Goddard researchers should be able to create a better unit.

Using an AdvR unit as the starting point, Goddard is improving the package design, and then AdvR will perform assembly and thorough testing. The goal is to assemble the laser's optomechanical components in the smallest, lightest package possible that can withstand launch and flight conditions and can operate for years in space. After laboratory specifications are met and verified, the laser will undergo flight qualification, including vibration and thermal vacuum testing.

If this project is successful, NASA will be able to obtain flight-qualified semiconductor seed lasers for about one-tenth the cost and less than one-twenty-fifth the volume, weight, and electrical budget of the present alternative. These lasers will be used in remote sensing; rover-based imagers; atmospheric, surface, and vegetation monitoring of Earth; and planetary mapping. Other uses under development include a pulsed version of AdvR's seeder for high-resolution 3D imaging in robotic and servicing applications.

Photo courtesy of New Scale Technologies, Inc.; all rights reserved.

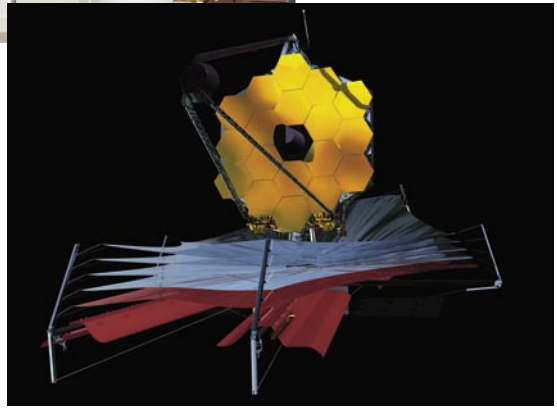
Super-Small, Super-Accurate Actuators for Space Missions and More

In FY05, Goddard partnered with New Scale Technologies of Victor, New York, to determine if the company's SQUIGGLE™ motor could be used as a cold-qualified actuator for future space telescopes.

The instruments in NASA's space-based observatories require millimeters of stroke, nanometer precision, and several Newtons of force while generating negligible vibration and heating. New Scale's tiny SQUIGGLE motor, which uses vibrations to rotate a screw, could serve as such an actuator. One additional requirement, however, is that the actuator must be able to withstand the extremely low temperatures of space.

Working in Goddard's Cryogenic Research and Integration Test Facility, researchers are testing the SQUIGGLE motor at temperatures as low as 4 Kelvin. The team then will work together to identify and demonstrate any needed improvements to the motor.

Photo courtesy of Lehigh University; all rights reserved.



Accessing University Facilities

Goddard has partnered with Lehigh University in Bethlehem, Pennsylvania, to gain access to equipment within the school's Nano- and Micro-Mechanical Behavior Laboratory (NMBL) as well as a cutting-edge microscope. This collaboration is expected to advance technologies for NASA's James Webb Space Telescope (JWST), which is scheduled to replace the renowned Hubble Space Telescope in 2011, as well as for Mars rovers and other spacecraft.

One of the many instruments that will fly aboard JWST is the near infrared spectrograph (NIRSpec), which is used to study galaxy and star formation, chemical abundances, active galactic nuclei, and more. NIRSpec's aperture is made up of an array of tiny shutters that can be programmed to open and close individually. The microshutters are made of thin films, whose performance at cryogenic temperatures and under torsional (i.e., twisting) stress is not fully understood. Tests conducted at Lehigh's NMBL will not only provide a useful understanding of the thin-film materials used in the microshutters but also begin to build a foundation for materials selection for future missions.

Another aspect of the partnership with Lehigh involves the testing of miniaturized low-leakage valves for use in mass spectrometers and other science instruments. These instruments could be used on a rover to understand the chemistry of Mars, such as whether the methane that has been observed is biogenic. However, current mass spectrometers are too large to be used in all the ways that space scientists would like. Miniaturizing the instrument's valves is one way that the overall system can be made smaller, enabling it to be used more effectively to search for signs of life on the Red Planet. Yet those valves also must provide high-quality, long-term performance without leaking. Working with Lehigh will help Goddard to improve the valve interface to ensure the seals are effective after repeatedly opening and closing.

A third element of the partnership with Lehigh is an opportunity for Goddard researchers to experiment with the school's new JEOL 2200FS transmission electron microscope (TEM) without ever leaving Maryland. That is because this cutting-edge instrument can be operated remotely. Other than loading the specimen, everything—from setting the apertures to controlling the alignment and acquiring data—can be controlled off-site, allowing Goddard researchers to image and chemically analyze individual columns of atoms in crystalline materials. Goddard is in the process of establishing an operation interface to Lehigh's instrument, which will allow the potential for space-based remote microscopy to be explored for future missions.

In addition to the benefits to future space missions, the partnership gives Lehigh students and faculty the chance to conduct real-world research with NASA.

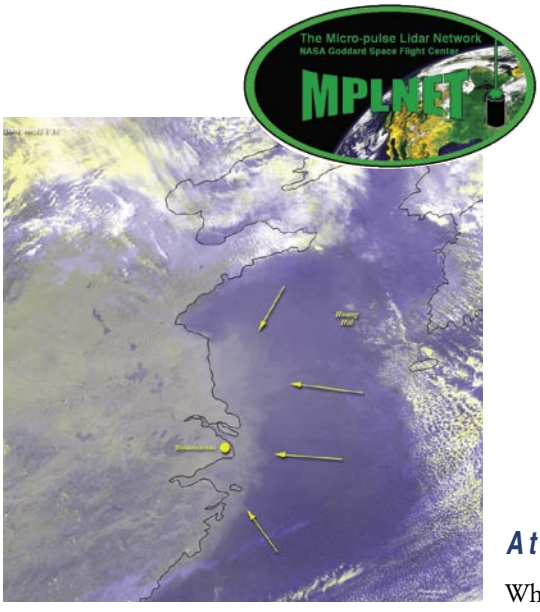
Photo courtesy of Army Research Lab; all rights reserved.

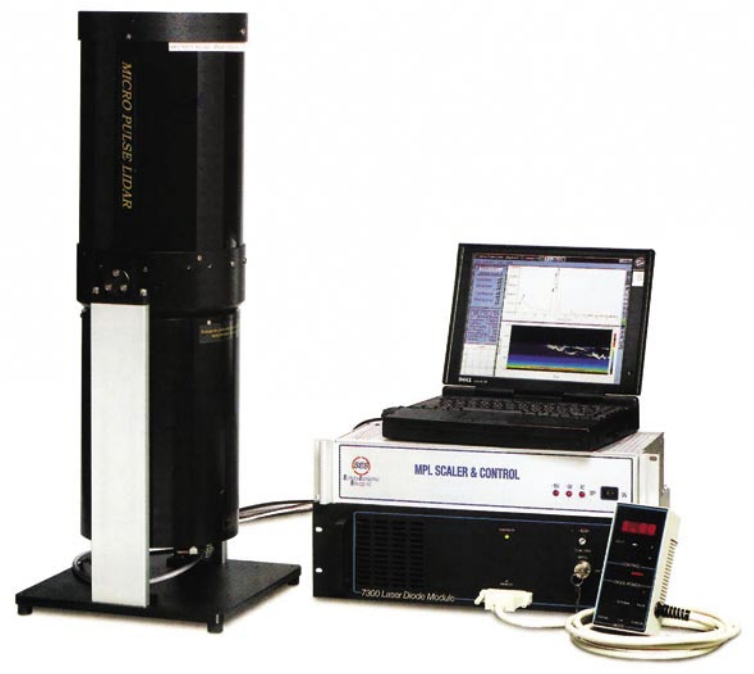
Accessing Two Government Facilities

Goddard has entered into partnership agreements with two federal agencies—the Army Research Laboratory (ARL) and the Air Force Research Laboratory (AFRL)—to develop joint programs of collaboration that enhance each lab's research capabilities. Such partnerships not only accelerate the development of new technologies but also make efficient use of federal research facilities.

Areas of collaboration with ARL include design, fabrication, and testing of nanoscience and microelectromechanical system (MEMS) devices and technologies for use in chemical and biological detectors, power generation, thermal management systems, radio frequency electronics, electro-optic devices, and distributed sensor networks. Under the agreement ARL personnel will have access to Goddard's Detector Development Laboratory, and Goddard personnel can access ARL's Specialty Electronic Materials and Sensors Cleanroom.

Under the agreement with AFRL, Goddard has access to the lab's Deployable Optics Testbed (DOT). AFRL established DOT to test technologies that are critical to the development of future space telescopes. An example of such a technology is wavefront sensing and control, which is designed to improve the optical quality of telescope lens elements. NASA is developing a wavefront sensing and control technology that, through the agreement, will be tested in AFRL's DOT.





Atmospheric Monitoring Takes a Step Forward

When researchers at Goddard developed its micro pulse lidar (MPL) instrument, the technology made lidar practical for routine monitoring of atmospheric particles, such as dust, pollution, and clouds. Unlike previous lidar systems, MPL is eye-safe, small, simple, reliable, long-range and operates unattended. The technology is significantly enhancing atmospheric research, particularly through the MPL Network (http://mplnet.gsfc.nasa.gov).

In 2005, Sigma Space Corp. became the second company to make the MPL instrument commercially available. Selected for its well-established record for high-quality engineering and products for space-flight and other research applications, Sigma offers an MPL that includes NASA's latest design and advances to improve performance and reliability of instruments.

Environmental companies and researchers can purchase their own MPL with standard specifications or have the device modified for their particular use. Sigma's MPL systems are in use in many lidar stations within the U.S. and worldwide, such as in Taiwan and Antarctica.

This recent technology transfer success was recognized by the Mid-Atlantic Region of the Federal Laboratory Consortium for Technology Transfer, which bestowed MPL and the MPL Network with its Excellence in Technology Transfer Award in September 2005. (For more information about this and other awards, see pages 23–24.)

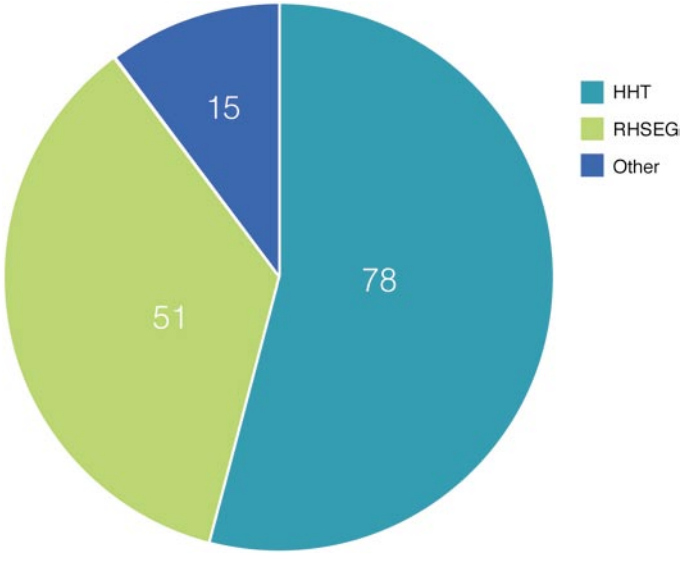
Nearly 150 Software Usage Agreements

Goddard researchers are continually developing innovative and versatile software, and many times NASA allows that software to be released into the public domain. Once approved for release, these programs can be used in applications outside of their original NASA purpose.

When researchers at other government agencies, U.S. and foreign universities, and commercial companies are interested in Goddard's released software, they enter into a Software Usage Agreement (SUA). An SUA allows Goddard's software to be used for internal research, collaboration, government use, licensing, or other applications.

Goddard's OTT facilitated the signing of several SUAs in 2005. Two of Goddard's most successful software programs—the Hilbert Huang Transform (see page 9) and the Recursive Hierarchical Segmentation Software (see page 7), which have been extensively promoted by OTT—accounted for the majority of the SUAs in 2005. Yet SUAs for other Goddard software programs proliferated as well.

In 2006, OTT will continue to pursue SUAs for HHT and RHSEG as well as for many other innovative, cutting-edge software programs developed at Goddard.



IP protection

What is IP protection?

IP protection involves filing for a patent (or copyright in the case of software) for technologies developed at Goddard. Because of the fees associated with patenting and because not every innovation is patentable, Goddard's Office of Technology Transfer first conducts an assessment to determine whether pursuing IP protection for a new technology is appropriate.

If the assessment concludes that patent protection should be pursued, OTT works with Goddard's Office of Patent Counsel to ensure that the necessary paperwork is filed with the U.S. Patent and Trademark Office (USPTO) and then begins to actively pursue technology transfer partnerships. Technologies not selected for patenting still enter the technology transfer process, which might include promoting the technology in journals such as *NASA Tech Briefs* or on Web sites. If a technology is still in the "idea phase," OTT might wait for further development or look into ways to provide additional project funding. (For more information on how Goddard makes its technologies available, see pages 18–22.)

Why is it important?

IP protection is important for those NASA technologies that have potential in the commercial marketplace as either a new product, an improvement to existing products, or a means to improve productivity. Companies seeking to use Goddard technologies for these purposes consider them valuable. Yet that value can be compromised, in some cases, if Goddard does not secure IP protection and other companies are able to have equal access to the technology, eliminating the opportunity to gain a competitive edge.

Furthermore, in most cases when a patented technology is licensed, Goddard negotiates to receive a licensing fee as well as upfront and ongoing royalty payments. These payments are shared by the inventor, which provides an incentive to develop high-quality inventions, and Goddard, which increases the return on the taxpayers' investment.

Our 2005 Accomplishments

Patents Issued

In fiscal year 2005, the USPTO issued six patents for Goddard-developed technologies:

U.S. patent no.	technology title
6,844,856	Minimum Cycle Slip Airborne Differential Carrier Phase GPS Antenna
6,847,354	Three-Dimensional Interactive Display
6,862,558	Empirical Mode Decomposition for Analyzing Acoustical Signals
6,895,115	Method for Implementation of Recursive Hierarchical Segmentation on Parallel Computers
6,901,353	Computing Instantaneous Frequency by Normalizing Hilbert Transform
6,936,122	Adhesive Bubble Removal Method and Apparatus for Fiber Optic Applications

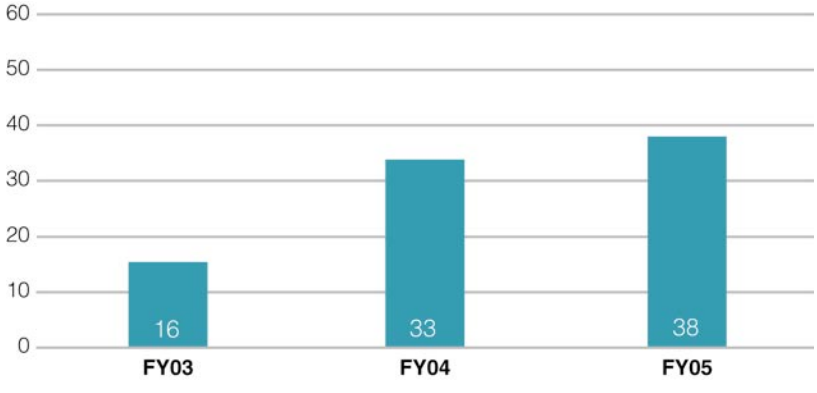
Patent Applications Filed

Two types of patent applications can be filed with the USPTO: provisional and nonprovisional applications. A full, nonprovisional patent application is a relatively complicated document to prepare with a significant filing fee, while provisional applications are less complicated to prepare and give the applicant an additional year to file the full application without compromising its IP protection rights.

Both types of applications are useful for Goddard's Office of Technology Transfer. A patent cannot be obtained from the USPTO without filing a full, nonprovisional patent application. But in some cases, Goddard needs time to determine whether a full, nonprovisional patent application should be filed. This is useful when additional testing of a new technology is needed or when the non-NASA potential for the technology is uncertain.

In FY05, Goddard filed 17 provisional and 21 full, nonprovisional patent applications. Total filings were up slightly from FY04 as shown in the chart below.

Patent Applications Filed (full and provisional)



partnering opportunities

What are partnering opportunities?

Every Goddard-developed innovation is made available to the nation's companies, universities, and other government laboratories, creating the opportunity for a partnership. The partnering-opportunity process begins when Goddard's civil servants and contractors who are conducting the innovative R&D to further NASA's missions disclose their new inventions to the Office of Technology Transfer via a New Technology Report (NTR).

In addition to the partnerships based upon Goddard-developed technologies, some opportunities relate to NASA mission needs. In these cases, OTT works with Goddard's research departments to determine which R&D projects could be accelerated with a partnership that brings in outside technology, facilities, or expertise.

Once it understands what technologies are available and what needs require partners, OTT uses standard, proven means as well as innovative approaches for successfully and cost-effectively communicating Goddard's partnering opportunities.

Why are they important?

Technology transfer is not possible without the opportunities created by Goddard innovators and OTT's outreach efforts to make them known to potential partners. In short, partnering opportunities are the foundation upon which all technology transfer success is based. As discussed on page 5, the benefits of this success include a faster innovation timeframe for NASA, efficient use of taxpayer resources, enhancements to the U.S. economy, and improved quality of life and public health.

Our 2005 Accomplishments

The largest proportion of partnering opportunities stem from Goddard's wealth of technologies developed for NASA. These technologies are reported to OTT via NTRs. For new technologies that are software programs, these can go through Goddard's Software Release Process to be made available for future Software Usage Agreements (see page 15) or as Open Source Software (see below right).

OTT then announces the availability of Goddard technologies through several outreach efforts, including the following.

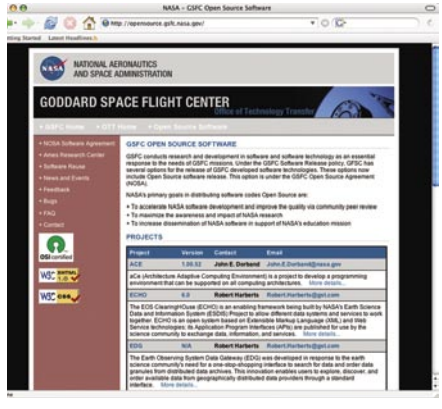
Publications Outreach

- OTT submits Goddard technologies for publication in *NASA Tech Briefs*, which is read by nearly 200,000 design engineers and managers.

- For Goddard technologies with the greatest potential for application outside of NASA, OTT prepares Technology Opportunity Sheets, which are one-page descriptions of technologies for which OTT is actively seeking licenses. These also are included on OTT's Web site as "Featured Technologies" (see below left).

Electronic Outreach

- OTT redesigned its Web site during FY05, giving it not only a new look but a new approach to presenting the content. For example, detailed information about the process for applying to license a technology or enter a partnering agreement was added. Goddard's hottest technologies are gathered into a "Featured Technologies" page, as well as highlighted on the home page. An "Inventor Resources" section explains the steps of technology transfer from an "insider's" point of view and provides a link to eNTRe, the online system for filing New Technology Reports. These and other changes to OTT's Web site make it easier for potential partners and Goddard innovators to participate in the technology transfer process.



- OTT created an Open Source Web site, which includes nearly a dozen software programs. More than 1,000 individuals around the world downloaded Goddard open-source software in FY05.

The following lists fiscal year 2005's partnership opportunities, including NTRs and released software as well as technologies announced in *NASA Tech Briefs* and as featured technologies on OTT's Web site.

Advanced Materials

Aluminum Substrates for Zeolite Molecular Absorbers

Design of a Lightweight, Low-Power Magnetometer Based on a Single-Walled Carbon Nanotube Mat

Development of a Two Part, Sprayable, Non-Flowing Polyurethane Conformal Coating Resin

High-Impulse Nanoparticulate-Based Gel Propellants

Laminated Plasma Spray Micro-Spheres

Micron and Submicron Pointed Structures‡

Oxygen Production Plant in the Lunar Environment: A Vacuum Pyrolysis Approach

Electrical Systems and Electronics

Driven Ground

Efficient Ultra Low Voltage Regulation Electronics

Electric Field Antenna for Solar Probe and Space Missions Exposed to High Photon Intensities within the Inner Heliosphere

ESD Strap for Grounding of Lab Coats

High-Voltage Opto-isolator (OP10KV)

High-Voltage Power Supply for Portable X-Ray System‡

High-Voltage Clock Driver for Photon Counting CCD Characterization

Hot-Filament Assisted Methanol-Based Method for Chemical Vapor Deposition of Diamond†

MEMS Structure for Electrophoretic and Dielectrophorertic Separation of Particles by Contactless Electrodes

Miniaturized Double Latching Solenoid Valve

Novel High Average Power Transceiver Design

Real-Time Parylene-Thickness Monitoring Optical Sensor System†

Thin-Film Parylene-C as a Sacrificial Layer for Microfabrication†

Ultrathin Silicon Circuits

Guidance, Navigation, and Control

Alignment Insensitive Active Center-of-Curvature Wavefront Sensing and Control Telescope Architecture

Altimeter Noise, Electromagnetic Bias, and Associated Software†

Angular Velocity Estimation of a Tumbling Hubble Space Telescope

Attitude Control System Design for the Solar Dynamics Observatory

AutoCon-f: Autonomous Maneuver Control Flight Software†

Balloon Ascent: 3D Simulation Tool for the Ascent and Float of High-Altitude Balloons

Common Ground Telemetry Archiving Architecture

Distributed Guidance and Control System for Satellite Constellations

Navigation Accuracy Guidelines for Orbital Formation Flying*

Nonlinear Attitude Filtering Methods

Orthogonal Attitude Filter

Pivot 2.0: Radiation-Hardened, Fast Acquisition/Weak Signal Tracking GPS Receiver†

Position-Finding Magnetometer for Space Application†

Requirements Tracing on Target (RETRO)

Spacecraft Zero Disturbance Momentum Unloading by Propulsion

Tool for Interactive Plotting, Sonification, and 3D Orbit Display (TIPSOD)†

Wilkinson Microwave Anisotropy Probe (WMAP) Command and Data Handling Flight Software

Information Systems

Apoptosis and Self-Destruct: Mechanisms for Management of Autonomic Systems

Automated Segmentation of Insulin Granules from Scanning Electron Micrographs (SEM) of Rat Pancreatic Beta Cells*

Board Support Package for the RTEMS Real-Time Operating System on the Motorola MCF5307C3 Processor Board

CCSDS File Delivery Protocol (CFDP) Software Library

COM+ Simulation Architecture with Application to Tethers and Formation Flying

Core Command and Data Handling Component*

Data Validation User Interface (DVUI): A Navigation/Discovery Client via Earth Observing System ClearingHOuse (ECHO)*

Development of a Low-Cost UAV Doppler Radar Data System

ECS Metadata Validator

Enhancements to a SQUID Multiplexer Readout and Control System

Ensemble Empirical Mode Decomposition: A Noise-Assisted Data Analysis Method

Fault-Tolerant Digital Signal Processing (DSP)*

Flow Solver for Incompressible 2-D Drive Cavity

Flow Solver for Incompressible 2-D Rectangular Domains

Formation Flying Testbed Software Architecture and Implementation*

Generation and Verification of Policies for Autonomic Systems

Global Change Master Directory's MD9, a Distributed JAVA-Based Directory Search Software System

Global Alert Resolution Network‡

HDF-EOS Extractor*

HDF-EOS Metadata Updater*

HDF-EOS To NetCDF Converter*

HDF-EOS Web Server*

HDF-EOS XML DTD and Schemas*

HDF-EOS2 and HDF-EOS5 Compatibility Library*

HDF-EOS5 Validator*

Hilbert Huang Transform‡

Hybrid Numerical Method for Solution of the Radiative Transfer Equation in One, Two, or Three Dimensions and Method of Using

Implementation of the Proper Orthogonal Decomposition of a Multivariate Time Series

Innovative Utilization of the Heap Data Structure for Efficient Determination of Best Merges for Hierarchical Segmentation

Integrated Test and Operations System Release 7-3*

Land Information System Software, Versions 3.1 and 4.0

Metadata Check*

Method and System for Procedure Development and Verification by Formal Specifications Derived Mechanically from Informal Procedure Descriptions*

Method of Deriving Process-Based Specifications from Scenarios via Pattern Matching

Metric Analysis Tool (MAT)*

Modular Tracking Filter and Tracking Data Source Management Software Library

ODL to XML Converter*

Offset Subtraction

Open Ticket Request System (OTRS) Software Improvements and Enhancements

Parallel Computing Tools for IDL*

Paramesh: Parallel Adaptive Mesh Refinement Library†

Planetary Balloon Software Theory Manual

Project Risk Information Management Exchange (PRIMX)

Projection to a Dynamical System for the Incompressible Navier-Stoke Equations

Propellant Slosh Analysis for the Solar Dynamics Observatory

Radio Software Library

Securing Data for Space Communications

Semantic Metrics for Object-Oriented Design†

Simple, Scalable, Script-Based Science Processing Archive*

Skymap Sky2000 Master Star Catalog Dump Utility MCDUMP†

Software Metrics Analysis Tool (SMAT)*

SPAACE: Self Properties for an Autonomous and Autonomic Computing Environment

Space Physics Data Facility Web Services†

SpaceWire PCI Card

Split-Remerge Method for Eliminating Processing Window Artifacts in Recursive Hierarchical Segmentation

Survey Editor and Player Software

Three-Dimensional Solid Models of Scientific Data for Education and Outreach†

TicTacToe Editor and Player Software

Tone-Based Command System for Reception of Very Weak Signals

Trending and Plotting System (TAPS)

Uncertainty Considerations for Ballistic Limit Equations

User-Friendly Metadata*

Using IV&V Findings to Perform FSW Technical Assessments*

Web-Based Help Management System

XML to HDF-EOS Converter

XML to ODL Converter*

Mechanical Systems

Bumper: Method of Retaining Payload Interior Structure within Its Skin While Allowing Maximizing of Interior's Components

Conformal Robotic Gripper‡

Fabrication Interlocking Support Walls, with an Adjustable Backshort, in a TES Bolometer Array

Hardware and Technique for Dead-End Welding of All Types of Tubing‡

Inexpensive Enhanced Mobility Pressure Suit

Integrated Structural Analysis and Test Program†

Method of Construction Truss Structures in Space

Micro-Resistojet for Small Satellites and Various Propellants Especially Methanol

Mini Linear Actuator†

Mini-Magnetospheric Plasma Propulsion for Orbital Transfers

Miniature Pump for Long-Life Biomedical Application‡

Miniature Redundant Lock Shape Memory Alloy Release Mechanism†

Modular Gear Bearings

Modular Spray-Cooled Assembly

Rad-Hard Reconfigurable Bi-Directional Level Shifters (ReBiLS) Technology for Micro- and Nanosatellites

Robotic Arm with Compact High-Power Joint Technology

Rotating Pair Programming Desk†

Space Plasma Alleviation of Regolith Concentrations in Lunar Environments (SPARCLE)

Space Robotic System for In-Space Servicing of Unmanned Spacecraft Application

String Pulley Actuated Telescope Strut System

T Slide

TETwalker‡

Unitary Graphite Composite Hinge‡

Photonics

4-Pass Coupler for Diode-Pumped Solid-State Lasers

Antireflecting Phase-Retarding Plate

Automated Spectroscopy of X-Ray Fluorescence Spectra

Broadband High Spurious-Suppression Microwave Bandpass Filter

Broadband High Spurious-Suppression Microwave Waveguide Filter for Polarization-Preserving and Transformer

Compact, Wide Spurious-Free Bandwidth Bandpass Filter Using Stepped Impedance Resonators

Diamond Machined, Freeform Mirror for Near-IR Astronomy

Disturbance-Photonics-Controls-Structures (DOCS) Toolbox

Estimation of Off-Axis Translational Errors for Interferometer Apertures

Estimation of Piston and Tip/Tilt Errors for Interferometer Apertures

Fiberator™†

Handheld L-Band Microwave Radiometer

High-Speed Fiber-Photonic Switching Array Using a Monolithic Beam Deflector

Image-Based Wavefront Sensing for Space Photonics Control

In Situ Microaradiometers: Smaller, Faster, and Scalable to Hyperspectral

Light-Emitting Diode Solar Simulator for Photovoltaic Cells

Method for Improved Geiger-Mode Photon Counting with Avalanche Photodiodes by Reducing After-Pulsing

Millimeter Wave Polarization Transformer

Modeling the Laser Interferometer Space Antenna Photonics

Multipurpose Fiber Injected Micro-Spherical Lidar System

Neutron Imaging Spectrometer

New Calibration Method for Cathetometer Systems†

Null Assembly with Aspheric Element

On-Chip Active Photonical Fiber Alignment System Using Gray-Scale Technology

Optical Encoder for Harsh Temperature Conditions†

Photonical Mixer for Interferometric Beam Combiner

Precision Slumping Mandrels by Diamond Turning

Pulsed, 1-Micron, Single-Frequency, Diode-Seeded Ytterbium-Doped Fiber Amplifier with Variable Output Parameters

Rugged IRIS Mechanism†

Solid-State Laser Gain Module Based on a Spoiled Hexagon Geometry

Spaceflight Ka-Band Transmitter

Very High Efficiency, High-Power Laser Diode Bars

Sensors and Detectors

Adaptive Sensor Fleet (ASF)

Advanced Autonomous Lidar Instrument for Airborne Remote Sensing

Characterization of the HEFT CdZnTe Pixel Detectors†

Cloud Water Content Sensor for Sounding Balloons and UAVs

Digital Receiver with Interference Mitigation for Microwave Radiometry†

Fast 3D Ion Mass Spectrometer for Solar Wind and Magnetospheric Plasmas

Growth Method for Improving Short Quantum Efficiency in Short-Wavelength HgCdTe Detectors

High-Rate Digital Receiver Board†

Light Direction Sensor

Low-Cost TDRSS Tranceiver (LCT2)

Magnesium Diboride Superconducting Coils for Adiabatic Demagnetization Refrigerators (ADRs)

MEMS-Based Image Stabilization for Imaging Sensor Performance Enhancement

Solar Extreme Ultraviolet Radiation Monitor with a Fresnel Zone Plate

Superconducting Tunnel Junction Arrays for UV Photon Detection

Use of Strain Gauges to Detect Bonded Joint Failures of Integrated Science Instrument Module (ISIM) at Cryogenic Temperatures

Thermal and Cryogenic Systems

Continuous Adiabatic Demagnetization Refrigerator for Cooling to 10 MK and Below

Free Vibration of Square Plate and Poisson's Ratio Measurement at Cryogenic Temperatures

High Heat Flux Evaporator for Two-Phase Transport Loops

Kinematic Kevlar Suspension System for an Adiabatic Demagnetization Refrigerator†

Lightweight Low-Current 10 Kelvin Magnet for Space-Flight ASRs

Metallurgical Stabilization Methods for Aluminum Mirrors Used in Cryogenic Environments†

Miniaturized Thermal-Cooler for IC Application

Spray Cooling Heat Transfer Numerical Modeling

Spray Cooling Heat Transfer Suction Evaporator

Thermal Transpiration Pump

Tightly Packaged Integral Flexure Mount Design for Cryogenic, Metal Mirrors for Astronomy Instruments

Notes:
† Published in *NASA Tech Briefs*
‡ Featured technology (http://techtransfer.gsfc.nasa.gov/technologies.html)
* Software released during FY05

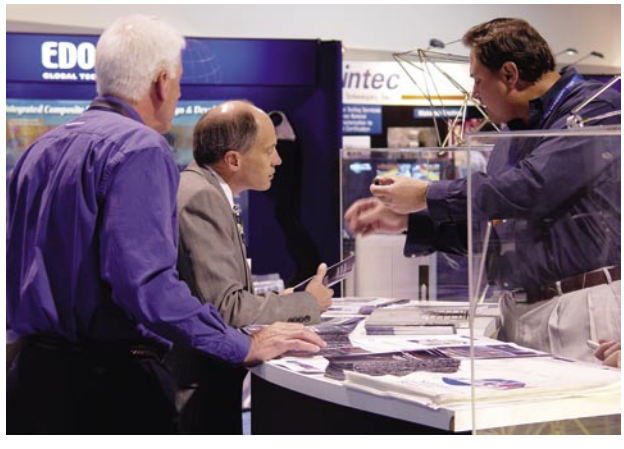
Events

- More than 100 Goddard scientists and researchers attended OTT's annual NTR Program in April 2005. Held at the Newton White Mansion in Mitchellville, Maryland, this event honors those who have reported new technologies or otherwise participated in technology transfer during the previous year. (For more information about OTT's awards program, see pages 23–24.)



- OTT presented three sessions as part of its Technology Transfer Investment Workshop series, which is designed to help researchers participate in the forming of high-impact partnerships. The final workshop for FY05 featured one of the authors of the highly acclaimed book *The Innovator's Solution*: Michael Raynor. The more than 100 Goddard researchers attending the workshop learned about make-vs.-buy decision making and "disruptive" technologies.

- OTT held a Joint Venture Workshop in Utica, New York. Designed to explore areas of mutual R&D interest and opportunities for joint research, the event was attended by more than 50 senior executives from 41 organizations. Several potential partnerships are being pursued.



- OTT attended more than 20 conferences hosted by other organizations to promote Goddard's partnering opportunities, including the National Design and Engineering Show, the RoboBusiness conference, a homeland security conference, small business conferences, and *NASA Tech Briefs* Nanotech 2005. These events gave OTT staff and Goddard researchers the opportunity to interact with potential partners, and several partnerships are being pursued.

the awards program

What is the Awards Program?

The Goddard OTT Awards Program consists of three types of awards. OTT submits Goddard technologies for NASA honors, such as Space Act Awards, which are sponsored by NASA's Inventions and Contributions Board (http://icb.nasa.gov). Secondly, Goddard technologies and innovators are eligible for awards from several external organizations, and OTT leads or assists in the application process. Finally, every year OTT bestows its own prestigious award, the Kerley Award, to honor a Goddard innovator who demonstrates exceptional commitment to technology transfer.

Why is it important?

Awards are important for several reasons. Recognizing the inspiration and dedication of Goddard innovators encourages them to strive for excellence in their scientific and engineering R&D. In addition, rewarding them for participating in technology transfer serves as valuable "word-of-mouth advertising" for this important NASA venture. Finally, the media coverage for awards boosts the nation's view of NASA Goddard as a source for innovative technology and collaborative partnerships for cutting-edge R&D.

Our 2005 Accomplishments

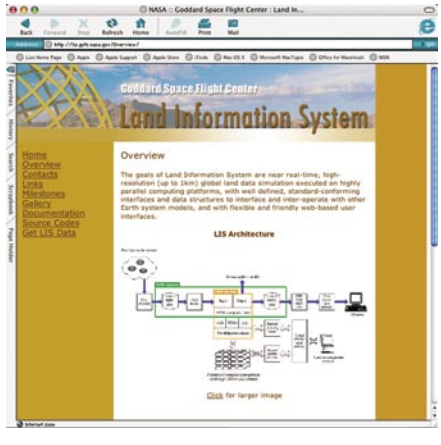
• Goddard's Center Director Dr. Edward Weiler presented OTT's 2005 Kerley Award to Peter Shirron for his work in transferring his adiabatic demagnetization refrigerator technology.

• OTT prepared the winning nomination for James Tilton for the Goddard's Excellence in Information Science and Technology Award for his Recursive Hierarchical Segmentation (RHSEG) software (see page 7).

• OTT prepared the nomination for two technologies that went on to win the 2005 Federal Laboratory Consortium (FLC) Mid-Atlantic Regional Excellence in Technology Transfer Award. The winning technologies were Goddard's Micro Pulse Lidar (MPL) and the MPL Network, which were spearheaded by Dr. James D. Spinhirne (front left) and Dr. Ellsworth Welton (front right), respectively. Also pictured (l to r) are team members Luis A. Ramos-Izquierdo, Sandra Valencia, Dennis Hlavka, and Stan Scott.

In FY05, OTT coordinated the application efforts for various awards from NASA's Inventions and Contributions Board, which resulted in the following:

- **Space Act Awards for 10 technologies (24 innovators)** Recognize exceptional scientific and technical contributions to NASA's mission
- **Patent Awards for 10 technologies (16 innovators)** Honor researchers whose inventions have received approval for patent application by NASA
- **Software Release Awards for 19 technologies (37 innovators)** Given to developers of software that has been approved for release by NASA to qualified users
- **Tech Brief Awards for 19 technologies (25 innovators)** Presented to researchers whose innovations have been reported in *NASA Tech Briefs*



• Goddard's Land Information System (LIS) software was a co-winner of NASA's 2005 Software of the Year Award, which recognizes excellence in software technology and places emphasis on those innovations that have a positive impact on NASA's mission and others areas of science and technology.

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