

NASA R&D in the FY 2005 Budget

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HIGHLIGHTS

- The FY 2005 budget request would provide \$16.2 billion to NASA, a 5.6 percent increase from the FY 2004 appropriation (see Table II-12). Total NASA support of R&D in FY 2005 would increase to \$11.3 billion, a 3.9 percent increase from FY 2004.
- On January 14, 2004, President Bush established a new vision for U.S. space exploration that seeks answers to longstanding questions of importance to science and society, develops revolutionary technologies and capabilities for the future, and genuinely inspires our nation, the world, and the next generation, while maintaining good stewardship of taxpayer dollars. The President's vision is documented in *A Renewed Spirit of Discovery, The President's Vision for U.S. Space Exploration*.¹
- To support the vision, NASA simultaneously released the FY 2005 Congressional Budget Justification, the FY 2005 Budget Estimates, and another document, *The Vision for Space Exploration*, that links NASA's program plans and the FY 2005 budget request to the exploration vision.
- NASA's FY 2005 budget request aligns with the goals set forth in *The President's Vision for U.S. Space Exploration* and provides a five-year budget plan for achieving these goals. The programs supported by this budget aim to discover new scientific insights, stimulate American innovation, and inspire young and old alike, while supporting the Administration goal of cutting the budget deficit in half over five years.
- NASA's budget accounts are renamed to reflect the President's exploration vision, with appropriations accounts entitled Exploration, Science, & Aeronautics (ESA), and Exploration Capabilities (EC), which includes programs that enable the ESA activities to succeed. For the

¹ http://www.nasa.gov/pdf/55583main_vision_space_exploration2.pdf

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second year, all program budgets are presented in full cost. This means institutional activities, such as personnel and facilities, are included in the benefiting program's budget, reflecting the true cost of the program and enabling managers to make better economic decisions.

- NASA will prepare for the planned retirement of the Space Shuttle following completion of its role in International Space Station (ISS) assembly. NASA will increase the ISS crew size to three and will resume ISS assembly after the Shuttle returns to flight.

POLICY GOALS

The fundamental goal of the new exploration vision is to advance U.S. scientific, security, and economic interests through a robust space exploration program. In support of this goal, NASA, in cooperation with its partners in other Federal agencies, academia, the private sector, and the international community, will: implement a sustained and affordable human and robotic program to explore the solar system and beyond; extend human presence across the solar system, starting with a human return to the Moon by the year 2020, in preparation for human exploration of Mars and other destinations; develop the innovative technologies, knowledge, and infrastructures both to explore and to support decisions about destinations for human exploration; and promote international and commercial participation in exploration to further U.S. scientific, security, and economic interests.

EXPLORATION PROGRAM ELEMENTS

Consistent with The President's *Vision for U.S. Space Exploration*, NASA has set a new course for exploration and discovery. Implementation of the exploration vision will be informed by the recommendations of the Aldridge Commission. There are 5 exploration program elements: Enhance Robotic Trailblazers, Finish the Space Station and Accelerate Research to Support Exploration, Develop New Crew Transport Capabilities, Return to the Moon and Demonstrate Sustainable Exploration Capabilities, and Go Beyond.

ORGANIZATIONAL CHANGES

In order to successfully execute the exploration vision, NASA will focus its organization, create new offices, align ongoing programs, experiment

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with new ways of doing business, and tap the great innovative and creative talents of our Nation. NASA has created a new Exploration Systems Enterprise (ESE) to develop the Crew Exploration Vehicle (CEV) and other exploration systems and technologies. Relevant elements of the Aerospace Technology, Space Science, and Space Flight Enterprises have transferred to ESE. The Aerospace Technology Enterprise is now the Aeronautics Enterprise to reflect its new focus.

As human explorers prepare to join their robotic counterparts, increased coordination and integration will be necessary. The Exploration Systems Enterprise will work closely with the Space Science Enterprise to use the Moon as a testing ground for exploration vehicles and technologies.

NASA's Space Science Enterprise will have responsibility for carrying out robotic testbeds on the Moon and Mars and will also demonstrate key exploration technologies in other missions to Mars and the outer moons. NASA's Space Science Enterprise will eventually integrate human capabilities into Mars science planning, and potentially deep space observatory and outer moon planning. Many other elements of the NASA organization will be focused to support this new direction.

NASA's Biological and Physical Research Enterprise will put much greater emphasis on bioastronautics research to enable human exploration of other worlds. NASA's Office of the Space Architect will be responsible for integrating the exploration activities of NASA's different Enterprises and for maintaining exploration roadmaps and coordinating high-level requirements.

As we move outward into the solar system, NASA will look for innovative ideas from the private sector and academia to support activities in Earth orbit and future exploration activities. NASA will actively seek international partners and lead the space agencies of these partners in executing exploration activities. NASA will also invigorate its workforce, focus its facilities, and revitalize its field Centers. The recently enacted NASA workforce flexibility legislation will be key to meeting future organizational challenges to exploration.

EXPLORATION, SCIENCE, AND AERONAUTICS (ESA)

Space Science Enterprise: The request for Space Science in FY 2005 is \$4.14 billion. In support of the exploration vision, orbiting observatories

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and planetary probes will be joined by human explorers in seeking answers to these profound questions: How did the universe begin and evolve? How did we get here? Where are we going? Are we alone? The Space Science Enterprise will work with the new Exploration Systems Enterprise to develop and deploy new technologies, first on automated spacecraft and then on human missions. The Space Science Enterprise is comprised of six Themes: Solar System Exploration, Mars Exploration, Lunar Exploration, Astronomical Search for Origins, Structure and Evolution of the Universe, and Sun-Earth Connection.

The Solar System Exploration request is \$1.2 billion in FY 2005. This funding will support missions to Saturn and Saturn's moon Titan, investigate evidence of oceans on Jupiter's icy moons, visit Mercury and Pluto, orbit the largest asteroids, and crack open the interior of a comet.

The President's request for Mars Exploration in FY 2005 is \$691 million and represents a \$96 million, or 16 percent, increase over FY 2004. By FY 2009, spending is planned to double to \$1.3 billion. The budget funds the operations of four spacecraft currently at Mars, four new spacecraft through 2010, technology for science missions after 2010, and a new line of test bed missions to support future human and robotic Mars exploration, with first launch in 2011.

The FY 2005 request is \$70 million for the new Lunar Exploration (LE) theme. By FY 2009, spending will increase six-fold to \$420 million. Funding supports a new line of robotic missions to demonstrate sustainable solar system exploration, including: a lunar orbiter planned for launch in 2008, a lunar landing planned for launch in 2009, and up to one lunar mission per year thereafter to demonstrate new exploration capabilities. The major focus of LE will be demonstrating capabilities to conduct sustained research on Mars as well as deeper and more advanced explorations of our solar system. The specifics of lunar missions and systems will be driven by the requirements of future human and robotic explorations of Mars and other solar system destinations, as well as by research results from ongoing robotic missions in the solar system. Lunar missions will also pursue scientific investigations on the Moon, such as uncovering geological records of our early solar system. Robotic lunar missions will begin in 2008, with human lunar missions as early as 2015.

The President's request for the Astronomical Search for Origins theme in FY 2005 is \$1.1 billion and represents a \$168 million, or 19 percent,

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increase over FY 2004. These increases support techniques to extend the Hubble Space Telescope's lifetime, James Webb Space Telescope development, Spitzer Space Telescope operation, and two additional space observatories.

NASA's Structure and Evolution of the Universe theme seeks to understand the nature and phenomena of the universe, the fundamental laws of space, time, and energy, and to trace the cycles that created the conditions for our own existence. The FY 2005 budget request is \$378 million for Structure and Evolution of the Universe missions. This funding supports operation of the Chandra X-ray Observatory, development of the Gamma-ray Large Area Space Telescope (GLAST) mission, and development of two future missions: Laser Interferometer Space Antenna (LISA) and Constellation-X. As a result of the reprioritized agency activities, development will be slowed down, and launch dates for Con-X and LISA will be deferred.

The proposed Sun-Earth Connections budget for FY 2005 is \$746 million. This funding supports the Solar Dynamics Observatory (SDO), development of the Solar-Terrestrial Relations Observatory (STEREO) mission, and other Living With a Star and Solar-Terrestrial Probe missions. (For more on astronomy in Space Science, see Chapter 15.)

Earth Science Enterprise (ESE): The FY 2005 Earth Science budget of \$1.5 billion represents a 7.9 percent decrease from FY 2004. The mission of ESE is to develop a scientific understanding of the Earth system and its response to natural and human-induced changes. NASA research and development of aerospace science and technology has resulted in deployment of the first series of Earth Observing System (EOS) satellites, which monitor the major interactions of the land, oceans, atmosphere, ice, and life that comprise the Earth system.

The Earth System Science request is \$1.4 billion. It includes \$54 million for the Climate Change Research Initiative (CCRI), making NASA's Earth Science Enterprise the largest contributor to the interagency Climate Change Science Program (CCSP) in FY 2005 (see Table I-10. For more on CCSP, see Chapter 16.) The request also provides \$141 million (a 36 percent increase above FY 2004) for development of the NPOESS Preparatory Project (NPP), in partnership with the National Oceanic and Atmospheric Administration and the Department of Defense. Additionally, the budget request includes \$560 million for

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research in Earth System Science (a 7 percent increase above FY 2004), allowing NASA to take advantage of data from 80 sensors on 18 operating satellites by supporting a steady level of competitive, world-class research, and \$240 million for missions in formulation (a 37 percent increase above FY 2004) including such missions as Orbiting Carbon Observatory, Aquarius, and Hydros.

The FY 2005 request of \$77 million will fund Earth Science Applications. The request includes funding for benchmarking the use of Earth observations from nine NASA Earth observatories into decision support tools through partnerships with eight federal agencies for air quality, agricultural efficiency, aviation, carbon management, coastal management, disaster management, ecological forecasting, energy management, invasive species, public health, and water management. Additionally, the budget request includes \$14 million for an enhanced outreach and education program to communicate significant Earth science research and application results, and to expand the Digital Earth Virtual Environment and Learning Outreach Project (DEVELOP). The request will sponsor over 150 projects to develop post-graduate, graduate, K-12, and informal education capacity for extending the use of Earth system science research results to serve society.

Biological and Physical Research (BPRE) Enterprise: The request for BPRE in FY 2005 is \$1.05 billion. BPRE has a unique role in support of NASA's Vision and Mission. In concert with the new exploration vision, BPRE will refocus research on activities that prepare human explorers to travel beyond low Earth orbit, such as the development of countermeasures against space radiation and the long-term effects of reduced gravity. Understanding how humans and other life forms adapt to the environment of space is a critical BPRE role. The FY 2005 budget will allow BPRE to complete and launch a wide range of research facilities to the ISS over the next five years that will enable exploration-focused research in biology and technology development. The FY 2005 budget fully supports increased BPRE research on ISS following return to flight. Four major facilities are completed and will be launched on the first two missions to ISS. BPRE will be conducting a thorough review of all research activities to achieve full alignment with and support of the new exploration vision.

The FY 2005 request for the Biological Sciences Research theme is \$492 million, a \$123.5 million (34 percent) increase above FY 2004, and a

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\$353 million (12 percent) increase over 5 years. It includes \$343 million (a 61 percent increase above FY 2004) for Bioastronautics Research, including the Human Research Initiative, to perform research and develop technology for systems that will enable humans to live and work safely and effectively in space. These research activities are aligned with the Bioastronautics Critical Path Roadmap, which identifies the critical risks associated with long-term human space travel. Additionally, an FY 2005 request of \$149 million will fund Fundamental Space Biology to focus on research on life's responses to space environments at all levels including cell sciences and genomics, physiological adaptation and developmental biology, ecosystem interactions and multigenerational studies, and the development of hardware for the Centrifuge Accommodation Module.

Within the Physical Sciences Research theme, NASA seeks ways to support research that uses the unique environment of space to expand our understanding of the fundamental laws of nature and to advance industrial and technological applications on Earth. This Theme also supports applied physical science and engineering research to develop reduced gravity technologies critical to human space exploration, such as radiation shielding, microgravity fire safety, and those elements of spacecraft power and propulsion systems that are gravity dependent. The Physical Sciences Research program develops technologies for space crew health programs and new processes to produce life-sustaining resources in a reduced-gravity remote environment. The FY 2005 request is \$300 million to continue important research in physical sciences. The request covers the development of hardware for inserts to be used with the ISS Research Facilities.

NASA requests \$257 million for the Research Partnerships and Flight Support Theme in FY 2005. In addition to establishing policies and allocating space resources to support space flight research, this theme encourages development of research partnerships in the pursuit of NASA missions and Enterprise scientific objectives. This research supports product development on Earth and accelerates progress in our strategic research areas. Ultimately, research partnerships may support development of an infrastructure that can be applied to human exploration. This Theme also funds ISS research planning, integration, and operations, as well as development and maintenance of research hardware that is used across multiple research disciplines such as the Express Rack and refrigerator/freezers.

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Aeronautics Enterprise: NASA's FY 2005 request for the Aeronautics Technology theme is \$919 million. By developing and transferring technologies, NASA's investments in aeronautics technology play a key role in creating a safer, more secure, environmentally friendly and efficient air transportation system, increasing performance of military aircraft, and developing new platforms for science or commercial uses. This Enterprise also enhances the Nation's security through its partnerships with the Department of Defense, the Department of Homeland Security, and the Federal Aviation Administration (FAA). Research areas include advanced propulsion technologies, lightweight high-strength adaptable structures, revolutionary display and control systems, adverse weather countermeasures, adaptive controls, advanced vehicle designs, and new collaborative design and development tools. In collaboration with the FAA, research is conducted in air traffic management technologies.

Aeronautics Technology consists of three integrated programs. The Aviation Safety and Security Program (AvSSP) with a FY 2005 request of \$188 million (a 4 percent increase above FY 2004) aims at reducing accident and fatality rates reducing the vulnerability of the aviation system to terrorist and criminal threat. The second program is the Airspace Systems (AS) with a request of \$154 million, and provides technologies that can dramatically increase the capacity and mobility of the nation's air transportation system. The last program Vehicle Systems (VS) develops enabling technologies that will produce future vehicles that are environmentally friendly, quieter, faster, more efficient, and technologically superior and supports science missions and commercial applications requiring high altitude, endurance, and remote operations.

Education Enterprise: The FY 2005 request for the Education Enterprise is \$169 million, including \$10 million for the newly authorized Science and Technology Scholarship program, \$14 million for the NASA Explorer Schools program, and \$91 million for minority university research and education (up 2 percent) to expand NASA's scientific and technical base through partnerships with Historically Black Colleges and Universities, Hispanic Serving Institutions, Tribal Colleges and Universities, and Other Minority Universities. Established in 2002 to inspire more students to pursue the study of science, technology, engineering, and mathematics, and ultimately to choose careers in aeronautics- and space-related fields, this Enterprise unifies the educational programs in NASA's other Enterprises and 10 field centers.

EXPLORATION CAPABILITIES

Exploration Systems Enterprise (ESE): The FY 2005 budget for the ESE is \$1.8 billion (see Table II-12). To enable an effective and exciting program of solar system exploration, the constraints of distance, energy, and time must be overcome. Meeting these challenges will require innovative approaches, new vehicles, and breakthrough technologies. The new ESE has been allocated \$13.4 billion over the next five years for developing and demonstrating the strategies and systems that will allow human and advanced robotic exploration of other worlds. ESE includes two new Themes that will function cooperatively to enable sustainable exploration and scientific discovery in the solar system: Human and Robotic Technology and Transportation Systems.

In FY 2005, the Human and Robotic Technology (HRT) theme will receive \$1.1 billion. This theme is responsible for developing innovative technologies to enable sustainable exploration of our solar system. For sustainable solar system exploration, NASA requires safe, affordable, effective, and flexible architectures, vehicles, and systems. This may require systems that can be reused, systems that are highly reliable and require limited maintenance and support, systems that can be applied to more than one destination, systems that can operate intelligently without human control, and architectures that use space resources to improve efficiency. NASA plans to invest in a number of new approaches and technologies for exploration that could enable these kinds of architectures, vehicles, and systems. These technologies will be demonstrated on the ground, at the Space Station and other locations in Earth orbit, and at the Moon starting this decade and into the next. Where they provide for safety, affordability, effectiveness, and flexibility in architectures, these new tools will be incorporated in full-scale, operational exploration systems.

The Transportation Systems (TS) theme, with a FY 2005 request of \$689 million, will provide crew transfer and other NASA-unique space transportation capabilities to support exploration of the solar system. The TS Theme will be focused on development and demonstration of a crew exploration vehicle under Project Constellation that can transport and support human crews traveling to destinations beyond low Earth orbit. The TS theme will also be responsible for planning for potential future NASA-unique space transportation needs, such as heavy lift launch, that cannot be met through commercial or international partner capabilities.

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The TS theme includes transition and closeout activities for the Orbital Space Plane and Next Generation Launch Technology programs.

Space Flight Enterprise: The Space Flight Enterprise programs ensure that the Nation will have reliable, safe, and affordable access to space for NASA's human and robotic explorers and open new exploration and research opportunities through the extension of human presence in Space. The Space Flight Enterprise programs include the following three themes: International Space Station (ISS), Space Shuttle, and Space Flight Support.

The FY 2005 request is \$1.9 billion (a 24 percent increase above FY 2004) for the International Space Station to continue assembly and operations. This Theme supports activities for establishing a research facility in Earth orbit aboard the ISS. All U.S. Core assembly flight elements and the first International Partner Laboratory have been delivered to the launch site. Upon completion of final ground integration, all assembly launch packages will be placed in protected stowage awaiting the Shuttle's return to flight.

The FY 2005 request is \$4.3 billion (a 9.5 percent increase above FY 2004) for Space Shuttle to return to flight and continue assembly of the ISS. This budget request includes \$680 million to the Shuttle program through FY 2007, with more than \$200 million in FY 2005, dedicated for return to flight activities. This includes high-priority mission assurance projects for safety, supportability, and infrastructure to combat obsolescence of vehicle, ground systems, and facilities. The Shuttle's retirement is planned for the end of the decade, following the completion of its role in the ISS assembly.

The Space and Flight Support Theme encompasses space communications, launch services, rocket propulsion testing, and environmental clean up. Space Communications supports the Space Shuttle, ISS, expendable launch vehicles, and research aircraft, and provides telecommunications services for flight support networks, mission control centers, science facilities, and administrative communications networks for NASA Centers. The FY 2005 request of \$492 million includes \$196 million (a 57 percent increase above FY 2004) for the Space Communications budget, and \$146 million (a 3 percent increase above FY 2004) for oversight of expendable launch vehicle flights and supporting payload carriers for Shuttle launches.