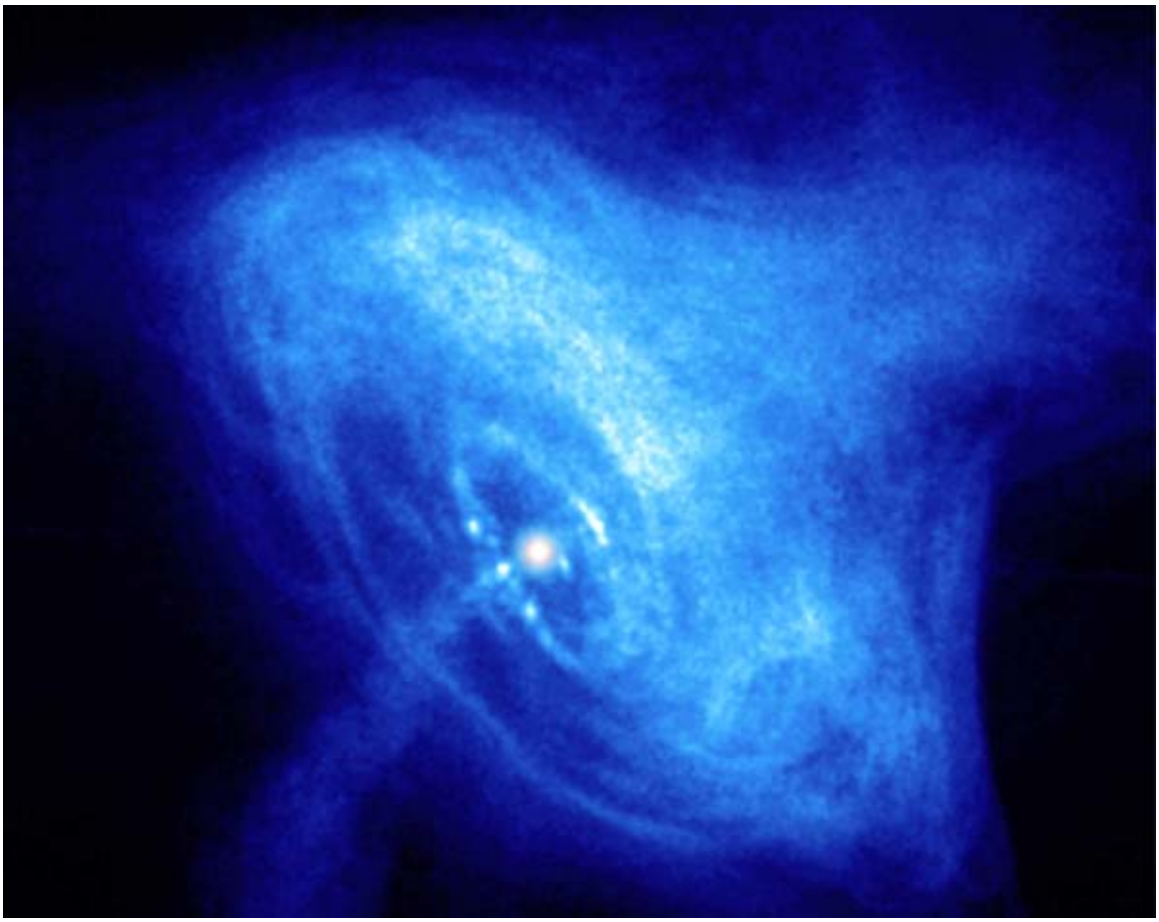
THEME: Structure and Evolution of the Universe



This image captures the spectacle of matter and antimatter propelled to near the speed of light by the Crab pulsar, a rapidly rotating neutron star the size of Manhattan. The Crab is the result of a supernova (a stellar explosion) that was observed by Chinese astronomers in 1054 A.D. The inner ring is about one light year across. Studies of the Crab are improving our understanding of what happens when a massive star dies and leading us toward a better understanding or the universe. More information can be found at http://universe.nasa.gov/

STRUCTURE AND EVOLUTION OF THE UNIVERSE

MAJOR EVENTS IN 2004

- SWIFT gamma-ray burst explorer begins science operations following launch in late 2003.
- GLAST will conduct its Critical Design Review.

THEME: Structure and Evolution of the Universe (SEU)

OVERVIEW

The Universe is a dynamic, evolving place. It is governed by cycles of matter and energy, an intricate series of physical processes in which the chemical elements are formed and destroyed, and passed back and forth between stars and diffuse clouds. The SEU theme seeks to understand these cycles and how they created the conditions for our own existence.

In FY04, the President's Budget request for SEU includes additional funding for the Beyond Einstein initiative. How did the Universe begin? Does time have a beginning and an end? Does space ever end? Einstein's theory of relativity replies to these ancient questions with three startling predictions: that the Universe is expanding from a Big Bang; that black holes so distort space and time that time stops at their edges. Observations confirm these remarkable predictions, the last finding being made only four years ago. Yet Einstein's legacy is incomplete. His theory raises—but cannot answer—three profound questions:

- What powered the Big Bang?
- What happens to space, time, and matter at the edge of a black hole?
- What is the mysterious, invisible dark energy pulling the Universe apart?

Missions	Goals supported by this theme	Objectives supporting those goals
Explore the Universe and Search for Life	5. Explore the solar system and the universe beyond, understand the origin and evolution of life, and search for evidence of life elsewhere.	5.7 Discover what powered the Big Bang and the nature of the mysterious dark energy that is pulling the Universe apart.
		5.8 Learn what happens to space, time, and matter at the edge of a black hole.
		5.9 Understand the development of structure and the cycles of matter and energy in the evolving Universe.
Inspire the Next Generation of Explorers	6. Inspire and motivate students to pursue careers in science, technology, engineering, and mathematics.	6.1 Improve student proficiency in science, technology, engineering and mathematics using educational programs, products and services based on NASA's unique missions, discoveries and innovations. (Supporting Role)
		6.2 Motivate K-16+ students from diverse communities to pursue science and math courses and ultimately college degrees in science, technology, engineering, and mathematics. (Supporting Role)
		6.3 Improve science, technology, and mathematics instruction with unique teaching tools and experiences that only NASA can provide, that are compelling to teachers and students. (Supporting Role)
		6.4 Improve higher education capacity to provide for NASA's and the Nation's future science and technology workforce requirements. (Supporting Role)
	7. Engage the public in shaping and sharing the experience of exploration and discovery.	7.1 Improve the capacity of science centers, museums, and other institutions, through the development of partnerships, to translate and deliver engaging NASA content. (Supporting Role)
		7.2 Improve science literacy by engaging the public in NASA missions and discoveries, and their benefits, through such avenues as public programs, community outreach, mass media, and the Internet. (Supporting Role)

THEME: Structure and Evolution of the Universe (SEU)

RELEVANCE

The Structure and Evolution of the Universe Theme seeks to answer questions that humankind has been pondering for millennia: How did the Universe begin? How will it end? What are the limits of matter and energy, of space and time? How did the Universe we see arise, and what are the laws of nature that have permitted life to arise in the Universe? These questions have been the basis of mythology and philosophy in the past. They have seemed unanswerable until now. Using cutting edge science and technology, the SEU missions seek the answers.

Education and Public Benefits

Black holes, the Big Bang, dark matter, and dark energy fascinate the American public and compel the attention of the news media and the entertainment industry. The SEU Theme leverages this fascination, with an education component that engages students in science and math and is aligned with national standards. It is a potent force with which to enhance science education and science literacy.

The origin of the Universe and black holes are central elements in K-12 science literacy standards and curricula. The television shows and educational materials for “Live from a Black Hole” and “Live from the Edge of Space” reached an estimated five million students. Public television’s NOVA program on dark energy ("Runaway Universe") was seen initially by more than two million Americans. SEU missions will soon provide the majority of materials on these subjects in our nation’s schools, weaving an ongoing story that is one of the most compelling in all science.

STATUS

RXTE, Chandra, XMM, HETE-2, MAP, and INTEGRAL are operational and producing outstanding science. In 2002, Chandra uncovered evidence for a new form of matter when it discovered a "strange quark star," even denser than nuclear matter on Earth. Chandra has also tracked the life cycle of x-ray jets being emitted at near-light speed from a black hole. HETE-2 identified a gamma-ray burst, and within seconds provided the an accurate position, so that it could be extensively studied at other wavelengths.

IMPLEMENTATION

The Structure and Evolution of the Universe theme is composed of many elements that work together to achieve the program's goals and objectives. Repeated management and scientific peer reviews ensure that each mission provides data in a cost-effective manner. In many cases, the data obtained from different missions are complementary, and are combined in cross-disciplinary studies by members of the scientific community.

Theme responsibility resides in the Office of Space Science at NASA Headquarters. Enterprise official is Dr. Ed Weiler, Associate Administrator for Space Science. Theme director and point of contact is Dr. Anne Kinney, Director of the Astronomy and Physics Division at Headquarters. This theme is in full compliance with NPG 7120.5B.

THEME: Structure and Evolution of the Universe (SEU)

IMPLEMENTATION - CONTINUED

Strategy	Schedule by Fiscal Year (96 97 98 99 00 01 02 03 04 05 06 07 08 09 10)	Purpose
Rossi X-ray Timing Explorer (RXTE)		Observe the high-energy worlds of black holes, neutron stars, x-ray pulsars and bursts.
Chandra X-ray Observatory (CXO)		Explore the hot, turbulent regions in space with images 25 times sharper than previous x-ray pictures.
XMM-Newton		Conduct sensitive X-ray spectroscopic observations of a wide variety of cosmic sources.
High Energy Transient Experiment (HETE-2)		Carry out a multiwavelength study of gamma ray bursts with UV, X-ray, and gamma ray instruments.
Microwave Anisotropy Probe (MAP)		Probe the early universe by measuring the cosmic microwave background radiation over the full sky.
International Gamma Ray Astrophysics Laboratory (INTEGRAL)		Unravel the secrets of the highest-energy - i.e. the most violent - phenomena in the Universe.
Cosmic Hot Interstellar Plasma Spectrometer (CHIPS)		Study the "Local Bubble" of hot gas surrounding our Solar System.
Galaxy Evolution Explorer (GALEX)		Explore the origin and evolution of galaxies and the origins of stars and heavy elements.
Gravity Probe-B (GP-B)		Precisely measure an effect that is predicted by all viable relativistic theories of gravity.
Swift		Study the position, brightness, and physical properties of gamma ray bursts.
Astro-E2		Unravel complex, high-energy processes and the behavior of matter under extreme conditions.
Planck		Testing theories of the early universe and the origin of cosmic structure.
Herschel		Help solve the mystery of how stars and galaxies were born.
Gamma Ray Large Area Space Telescope (GLAST)		Study the high energy gamma rays from natural particle accelerators throughout the Universe.
Link to Additional Mission Information	Tech. & Adv. Concept; Development; Operations	

Tailoring
No exceptions to NPG 7120.5B have been taken.

THEME: Structure and Evolution of the Universe (SEU)

PERFORMANCE MEASURES

Annual Performance Goals	
	OUTCOME: A well managed program in accordance with Agency implementing strategies.
4SEU1	Each Development project will complete its current phase within 10% of total life-cycle cost shown on the table below.
4SEU2	Each Research project will allocate 75% of its funding competitively during FY04.
4SEU3	SEU will complete all of its missions within 10% of their baseline schedules.
5.7.1	OUTCOME: Discover what powered the Big Bang and the nature of the mysterious dark energy that is pulling the Universe apart.
4SEU4	Successfully demonstrate progress in search for gravitational waves from the earliest moments of the Big Bang. Progress towards achieving outcomes will be validated by external review.
4SEU5	Successfully demonstrate progress in determining the size, shape, and matter-energy content of the Universe. Progress towards achieving outcomes will be validated by external review.
4SEU6	Successfully demonstrate progress in measuring the cosmic evolution of the dark energy, which controls the destiny of the Universe. Progress towards achieving outcomes will be validated by external review.
5.8.1	OUTCOME: Learn what happens to space, time, and matter at the edge of a black hole.
4SEU7	Successfully demonstrate progress in determining how black holes are formed, where they are, and how they evolve. Progress towards achieving outcomes will be validated by external review.
4SEU8	Successfully demonstrate progress in testing Einstein's theory of gravity and mapping space-time near event horizons of black holes. Progress towards achieving outcomes will be validated by external review.
4SEU9	Successfully demonstrate progress in observing stars and other material plunging into black holes. Progress towards achieving outcomes will be validated by external review.
5.9.1	OUTCOME: Understand the development of structure and explore the cycles of matter and energy in the evolving Universe.
4SEU10	Successfully demonstrate progress in determining how, where, and when the chemical elements were made, and tracing the flows of energy and magnetic fields that exchange them between stars, dust, and gas. Progress towards achieving outcomes will be validated by external review.
4SEU11	Successfully demonstrate progress in exploring the behavior of matter in extreme astrophysical environments, including disks, cosmic jets, and the sources of gamma-ray bursts and cosmic rays. Progress towards achieving outcomes will be validated by external review.
4SEU12	Successfully demonstrate progress in discovering how the interplay of baryons, dark matter, and gravity shapes galaxies and systems of galaxies. Progress towards achieving outcomes will be validated by external review.
6.1.1	OUTCOME: Kindergarten through graduate students will be more proficient in science, technology, engineering, and mathematics (STEM).
4SEU13	Provide opportunities for students to work directly with NASA space science missions, facilities, and data.
6.2.1	OUTCOME: More students from diverse communities motivated to pursue careers in STEM.
4SEU14	Provide new opportunities for participation in the space science program by an increasingly diverse population, including opportunities for minorities and minority universities to compete for and participate in space science missions, research, and education programs.
6.3.1	OUTCOME: Improve the quality of STEM education.
4SEU15	Provide high quality educational materials and teacher training based on Theme content and focused on national curriculum standards.
4SEU16	Provide exhibits, materials, workshops, and personnel at national and/or regional education and outreach conferences.
6.4.1	OUTCOME: More students prepared to enter the STEM workforce.
4SEU17	Provide higher education opportunities offered through OSS research awards and other NASA research and education programs.
7.1.1	OUTCOME: Improve the capacity of science centers, museums, and other institutions, through the development of partnerships, to translate and deliver engaging NASA content.
4SEU18	Through partnerships with major science museums or planetariums, put on display or on tour major exhibitions or planetarium shows based on Theme content.
4SEU19	Provide materials and technical expertise to support the development of exhibits and programs at science museums and planetariums.
7.2.1	OUTCOME: Engage the public in NASA missions and discoveries through such avenues as public programs, community outreach, mass media, and the Internet.
4SEU20	Seek out and capitalize on special events and particularly promising opportunities in the Theme science program to bring space science to and involve the public in the process of scientific discovery.

THEME: Structure and Evolution of the Universe (SEU)

INDEPENDENT REVIEWS

Types of Review	Performer	Last Review	Next Review	Purpose
Nat'l Academy of Sciences	Space Studies Board	7/02	TBD	Effectiveness and quality of the program
Advisory Council	NAC	9/02	3 times/year	Review science strategy, prog. Imp. strategy
	SSAC	8/02	3 times/year	Review science strategy, prog. Imp. strategy
	SEU Subcommittee	8/02	3 times/year	Review science strategy, prog. Imp. strategy

BUDGET

Budget Authority ($millions)	FY02	FY03	Chng	FY04	Comments
SEU	**350.1**	**331.1**	**+100.5**	**431.6**	
Development	198.9	144.8	+28.9	173.8	
GP-B	54.1	19.7	-19.7		
GLAST	20.7	69.2	+46.5	115.7	
Swift	66.9	33.5	-33.5		
Small Projects	57.3	22.4	+35.7	58.1	
Operations	6.4	10.7	-0.4	10.3	
Research	131.7	154.0	+32.6	186.6	
Technology and Advanced Concepts	13.0	21.5	+39.4	60.9	Includes New Initiative - Beyond Einstein (see SAE 5-2).

Note: For all formats, the FY 02 column reflects the FY 2002 Congressional Operating Plan dated 9/30/02. The FY 03 column reflects the FY 2003 President's Budget Submit (PBS) as Amended. The Change column includes both programmatic and full cost adjustments. FY 2004 column is in full cost.

Indicates budget numbers in Full Cost.
Indicates changes since the FY 2003 President's Budget Submit.
FY 2002 and FY 2003 are not in full cost.

THEME: Structure and Evolution of the Universe (SEU)

DEVELOPMENT: Gravity Probe B (GP-B)

PURPOSE

Objectives	Reference 2003 Strategic Plan	Performance Measures
5.7, 5.8, 5.9, 6.1, 6.2, 6.3, 6.4, 7.1, 7.2		4SEU1,3,8,13-20

The purpose of Gravity Probe B is to verify certain extraordinary predictions of Einstein's theory of general relativity. This is the most accepted theory of gravitation and of the large-scale structure of the Universe. General relativity is a cornerstone of our understanding of the physical world, and consequently of our interpretation of observed phenomena. An experiment is needed to explore and test more precisely the predictions of Einstein's theory in two areas: (1) a measurement of the "dragging of space" by rotating matter; and (2) a measurement of space-time curvature known as the "geodetic effect." The dragging of space has never been directly measured, and the geodetic effect needs to be measured more precisely. The precision required to make these measurements can only be achieved in space. Whether the experiment confirms or contradicts Einstein's theory, its results will be of the highest scientific importance. The measurements of both the frame dragging and geodetic effects will allow Einstein's theory to be either rejected or given greater credence. The effect of invalidating Einstein's theory would be profound, and would call for major revisions of our concepts of physics and cosmology.

OVERVIEW

The GP-B experiment will check, very precisely, tiny changes in the direction of spin of four gyroscopes contained in an Earth satellite orbiting at a 400-mile altitude directly over the poles. So free are the gyroscopes from disturbance that they will provide an almost perfect space-time reference system. They will measure how space and time are warped by the presence of the Earth, and, more profoundly, how the Earth's rotation drags space-time around with it.

GP-B is scheduled for launch in the latter half of FY 2003. NASA's FY 2004 budget request includes funding for GP-B under Operations and Data Analysis; no funds are requested for Development.

PROGRAM MANAGEMENT

GP-B is a single-project program with program responsibility delegated to the Marshall Space Flight Center. The Agency Program Management Council (PMC) has GP-B governing responsibility. Enterprise official is Dr. Ed Weiler, Associate Administrator for Space Science at HQ. The Theme Director and the Point of Contact is Dr. Anne Kinney, Director of the Astronomy and Physics Division at HQ. This program is in full compliance with NPG7120.5B.

TECHNICAL COMMITMENT

The baseline for this technical commitment was made in 3/1998 and is detailed in the GP-B Program Commitment Agreement (PCA).

Technical Specifications	FY04 President's Budget	Change from Baseline
Geodetic Accuracy	Less than 0.5 milliarcseconds per year.	--
Cryogenic Temperature	Maintained at less than -271 degrees Celsius for at least 16 months.	--
Data Gathering	At least 12 months.	--
Data Telemetry	To Stanford University or backup site.	--

Schedule	FY04 President's Budget	Change from Baseline
Payload/SC Integration	Oct-01	+2.0 years
Launch	Apr-03	+2.5 years

THEME: Structure and Evolution of the Universe (SEU)

DEVELOPMENT: Gravity Probe B (GP-B)

ACQUISITION STRATEGY & PERFORMING ORGANIZATIONS

Stanford University is responsible for the scientific payload, and will provide spacecraft tracking and communications. Stanford also subcontracts with Ball Aerospace and Lockheed Martin Astronautics for the rest of the flight hardware. Ball provided the cryogenic dewar, and Lockheed Martin is providing the spacecraft and telescope. In FY02, direct procurement represented 100% of budget authority. **Changes since FY03 Pres. Budget: None.**

Current Acquisitions	Actual *	Selection Method	Actual *	Performer	Actual *
Cooperative Agreements	0%	Full & Open Competition	6%	Industry	7%
Cost Reimbursable	92%	Sole Source	94%	Government	
Fixed Price	3%		100%	NASA Intramural	4%
Grants	0%			University	89%
Other	5%	Sci Peer Review	100%	Non Profit	1%
* as % of FY02 direct procurement	100%	* as % of FY02 direct procurement		* as % of FY02 direct procurement	100%

Future Acquisitions - Major	Selection	Goals
1. None - all major acquisitions are in place.	n/a	n/a

AGREEMENTS

Internal: The program is not dependent on other NASA activities outside of the control of the Associate Administrator for Space Science. *External:* None. **Changes since FY03 Pres. Budget: None.**

INDEPENDENT REVIEWS

Types of Review	Performer	Last Review	Next Review	Purpose
Schedule assessment	IRT	19-Apr-02	TBD	Assess feasibility of schedule plan.
Annual Review	IRT	12-Sep-02	TBD	Annual review, with focus on mission operations.

BUDGET/LIFE CYCLE COST

Budget Authority ($ in millions)	Prior	FY02	FY03	FY04	FY05	FY06	FY07	FY08	Total	Comments
FY 2004 President's Budget (LCC)	565.2	54.1	28.9	14.6	5.8				668.6	
Development	565.2	54.1	19.7						639.0	
Operations			2.0	1.1					3.1	
Data Analysis			7.2	13.6	5.8				26.6	
Changes since FY 03 Pres. Budget	+0.5	+8.0		+5.1	+3.9				+17.5	***Reason for Change:***
Development	+0.5	+8.0							+8.5	Launch delay and assoc. overrun.
Operations				+0.1					+0.1	Full cost.
Data Analysis				+5.1	+3.9				+9.0	Launch delay and full cost.
FY 2003 President's Budget (LCC)	564.7	46.1	28.9	9.5	1.9				651.1	Cost growth due to various
Development	564.7	46.1	19.7						630.5	unanticipated tech challenges,
Operations			2.0	1.0					3.0	late delivery of payload.
Data Analysis			7.2	8.5	1.9				17.6	
Initial Baseline (LCC)	550.4								550.4	FY 97 Budget, Oct. '00 launch.
Development	529.6								529.6	
Operations	3.0								3.0	
Data Analysis	17.8								17.8	

Indicates budget numbers in full cost.
Indicates changes since the FY 2003 President's Budget Submit.
FY 2002, FY 2003, Prior and BTC are not in full cost.

THEME: Structure and Evolution of the Universe (SEU)

DEVELOPMENT: Gamma-ray Large Area Space Telescope (GLAST)

PURPOSE

Objectives		Performance Measures
5.7, 5.8, 5.9, 6.1, 6.2, 6.3, 6.4, 7.1, 7.2	Reference 2003 Strategic Plan	4SEU1,3,11,13-20

The GLAST program improves our understanding of the structure of the Universe, from its earliest beginnings to its ultimate fate, and explores the limits of gravity and energy in the Universe. GLAST measures the direction, energy, and arrival time of celestial high-energy gamma rays. The goal of GLAST is to map the sky with 50 times the sensitivity, resolution, and coverage of previous high-energy gamma-ray missions.

OVERVIEW

GLAST will provide new insights into the sources of gamma-ray bursts and high-energy cosmic gamma-rays, and reveal the nature of cosmic jets and relativistic flows. GLAST will provide a new tool to study how black holes, notorious for pulling matter in, can accelerate jets of gas outward at fantastic speeds. Physicists will be able to study subatomic particles at energies far greater than those seen in ground-based particle accelerators. They will also gain insight into the puzzling question of how energetic gamma-rays are produced in the magnetosphere of spinning neutron stars. Perhaps the biggest return will come from understanding the nature of the high-energy gamma-ray sources that have escaped detection at other wavelengths; these high-energy sources constitute the bulk of the 273 sources known. GLAST is a collaboration with the Department of Energy, France, Italy, Sweden, and Germany.

PROGRAM MANAGEMENT

GLAST is a single-project program with program responsibility delegated to the Goddard Space Flight Center. Enterprise official is Dr. Ed Weiler, Associate Administrator for Space Science at NASA HQ. The Theme Director and point-of-contact is Dr. Anne Kinney, Director of the Astronomy and Physics Division at HQ. This program is in full compliance with NPG7120.5B.

TECHNICAL COMMITMENT

The baseline for this technical commitment is the Formulation Authorization Document (FAD).

Technical Specifications	FY04 President's Budget	Change from Baseline
LAT - Large Area Telescope		
- Collection Area	1,000 - 13,000 sq. centimeters (depends on energy of photon).	--
- Energy Range	20 MeV - 300 GeV	--
- Spatial Resolution	5 arcminutes - 5 degrees (depends on energy of photon).	--
GBM - GLAST Burst Monitor		
- Collection Area	40 - 110 sq. centimeters (depends on photon energy and off-axis angle).	--
- Energy Range	10 keV - 25 MeV	--
- Spatial Resolution	3 degrees	--
Spacecraft Pointing Knowledge	5 arcsec	--
Operational Capability	5-yr. Life, pointing and scanning modes, immediate burst notice to ground.	--

Schedule	FY04 President's Budget	Change from Baseline
PDR	Feb-03	--
NAR	Mar-03	--
CDR	Feb-04	--
Launch	Sep-06	--

THEME: Structure and Evolution of the Universe (SEU)

DEVELOPMENT Gamma-ray Large Area Space Telescope (GLAST)

ACQUISITION STRATEGY & PERFORMING ORGANIZATIONS

Major acquisitions for GLAST are the Large Area Telescope (LAT) at Stanford University and the GLAST Burst Monitor (GBM) at Marshall Space Flight Center. Spectrum Astro Inc. will provide the spacecraft. The Science Operations Center will be a NASA solicitation or GSFC development. Guest Observers will be selected via a NASA solicitation. The Mission Operations Center will be managed in-house by GSFC. **Changes since FY03 Pres. Budget: None.**

Current Acquisitions	Actual *	Selection Method	Actual *	Performer	Actual *
Cooperative Agreements	0%	Full & Open Competition	100%	Industry	46%
Cost Reimbursable	88%	Sole Source	0%	Government	
Fixed Price	5%		100%	NASA Intramural	10%
Grants	0%			University	26%
Other	7%	Sci Peer Review	100%	Non Profit	18%
* as % of FY02 direct procurement	100%	* as % of FY02 direct procurement		* as % of FY02 direct procurement	100%

Future Acquisitions - Major	Selection	Goals
1. None - all major procurements are in place	n/a	n/a

AGREEMENTS

Internal: The program is not dependent on other NASA activities outside of the control of the Associate Administrator of Space Science. *External:* Collaboration with Dept. of Energy, France, Italy, Japan and Sweden. **Changes since FY03 Pres. Budget: None.**

INDEPENDENT REVIEWS

Types of Review	Performer	Last Review	Next Review	Purpose
Indep Annual Review	TBD	N/A	TBD	Independent Review.
Non Advocate Review	IRT	N/A	Feb. 03	Outside Review.
Confirmation Review	TBD	N/A	TBD	Authorization to proceed to development phase.

BUDGET/LIFE CYCLE COST

Total budget authority represents the Life Cycle Cost (LCC).

Budget Authority ($ in millions)	Prior	FY02	FY03	FY04	FY05	FY06	FY07	FY08	* BTC	Total	Comments
FY 2004 Pres. Bud. (LCC)	12.6	20.7	69.2	115.7	86.6	91.2	60.4	25.1	172.5	654.0	
ATD	12.6									12.6	
Development		20.7	69.2	94.4	53.3	62.3	38.6			338.6	
Launch Services				21.3	33.3	28.9				83.5	
Mission Operations							5.5	5.8	28.2	39.4	
Data Analysis							16.3	19.4	144.3	179.9	
Changes since FY03 Pres. Bud.				+9.0	+11.6	+47.8	+40.2	+25.1	+10.7	+133.7	***Reason for Change:***
Development				+19.8	+6.0	+38.9	+38.6			+103.4	Full cost plus revised technical requirements.
Launch Services				-10.8	+5.6	+18.0				+12.8	Larger launch vehicle.
Mission Operations						-2.5	+0.8	+5.8	-5.0	-1.0	
Data Analysis						-6.6	+0.8	+19.4	+15.7	+29.2	Full cost; added reserves in BTC.
FY 2003 Pres. Bud. (LCC)	12.6	20.7	69.2	106.7	75.0	43.4	20.2		161.8	509.6	
ATD	12.6									12.6	
Development		20.7	69.2	74.6	47.3	23.4				235.2	
Launch Services				32.1	27.7	10.9				70.7	
Mission Operations						2.5	4.7		33.2	40.4	
Data Analysis						6.6	15.5		128.6	150.7	
Initial Baseline (LCC)											Will be established at Confirmation Review.

Indicates budget numbers in full cost.
Indicates changes since the FY 2003 President's Budget Submit.
FY 2002, FY 2003, Prior and BTC are not in full cost.

THEME: Structure and Evolution of the Universe (SEU)

DEVELOPMENT: Swift Gamma-Ray Burst Explorer

PURPOSE

Objectives	Reference 2003 Strategic Plan	Performance Measures
5.7, 5.8, 5.9, 6.1, 6.2, 6.3, 6.4, 7.1, 7.2		4SEU1,3,11,13-20

Studying approximately 500 gamma-ray bursts in its two-year prime mission, Swift has the capability to determine the origin of the still-mysterious gamma-ray bursts, and to use them to probe the conditions that existed in the early Universe. Swift is the first mission to focus on studying the afterglow from gamma-ray bursts. Swift will determine redshifts for most of the bursts that it detects (allowing us to know how far away they are and how bright they are in absolute terms), and will also provide detailed multi-wavelength light curves for the duration of the afterglow (allowing us to probe the physical environment in which the event took place).

OVERVIEW

Swift is a NASA medium-size Explorer (MIDEX) mission being developed by an international collaboration for launch in 2003. Foreign participation includes Italy and the United Kingdom. The Swift mission consists of three science instruments; Burst Alert Telescope (BAT); X-Ray Telescope (XRT); and the UltraViolet/Optical Telescope (UVOT). The Swift spacecraft is being built by Spectrum Astro and will be launched on a Delta 2420.

PROGRAM MANAGEMENT

Swift is a NASA medium size Explorer (MIDEX) mission with project responsibility delegated to the Goddard Space Flight Center. Enterprise official is Dr. Ed Weiler, Associate Administrator for Space Science at HQ. The Theme Director and the Point of Contact is Dr. Anne Kinney, Director of the Astronomy and Physics Division at HQ. This program is in full compliance with NPG7120.5B.

TECHNICAL COMMITMENT

The technical commitment was made in 02/01 and is detailed in the SWIFT Level I Requirements Document appended to the Explorers Program Plan.

Technical Specifications	FY04 President's Budget	Change from Baseline
Determine the Origin of GRB	Detect and image 300 (+10%).	--
Number of GRBs Observed	Baseline of 300/Minimum of 200.	--
Number of Afterglows Studied	Baseline 200/Mimimum 75.	--
Mission Life	3 years	--
Operations	All GRB positions will be made available within seconds of their generation. Processed data will be available within 30 minutes.	--

Schedule	FY04 President's Budget	Change from Baseline
Start of Implementation	Feb-01	--
Mission Critial Design Review	Jul-01	--
NSI Instrument Delivery	Nov-02	--
BAT Instrument Delivery	Feb-03	--
Complete S/C I & T	Jul-03	--
Launch	Sep-03	--

THEME: Structure and Evolution of the Universe (SEU)

DEVELOPMENT: Swift Gamma-Ray Burst Explorer

ACQUISITION STRATEGY & PERFORMING ORGANIZATIONS

The Swift project has three instruments: the Burst Alert Telescope built by GSFC; and the X-Ray Telescope and UV/Optical Telescope which are built by Penn State University. The Principal Investigator is located at GSFC. The spacecraft provider is Spectrum Astro Inc. Swift will be launched on a Delta 7320 from the Kennedy Space Center. Operations will be conducted at the Mission Operation Center at PSU. Archive sites are in the USA, UK, and Italy.

Changes since FY03 Pres. Budget: None.

Current Acquisitions	Actual *	Selection Method	Actual *	Performer	Actual *
Cooperative Agrmts.	0%	Full & Open Competition	60%	Industry	80%
Cost Reimbursable	57%	Sole Source	30%	Government	
Fixed Price	24%		100%	NASA Intramural	2%
Grants	0%			University	18%
Other	19%	Sci Peer Review	100%	Non Profit	%
* as % of FY02 direct procurement	100%	* as % of FY02 direct procurement		* as % of FY02 direct procurement	100%

Future Acquisitions - Major	Selection	Goals
1. none - all major procurements are in place	n/a	n/a

AGREEMENTS

Internal: The program is not dependent on other NASA activities outside of the control of the Associate Administrator for Space Science.

External: International agreements are with the United Kingdom for the UVOT and XRT, and with Italy for the XRT and ground system support. **Changes since FY03 Pres. Budget: None.**

INDEPENDENT REVIEWS

Types of Review	Performer	Last Review	Next Review	Purpose
Confirmation Review	GSFC	Feb 16 2001	N/A	Approval to proceed into Development.
Mission Operation Review	GSFC	1-Aug-02	N/A	To certify all operations are ready to proceed.
Mission Readiness Review	GSFC	N/A	Aug-03	Verify readiness for launch.

BUDGET/LIFE CYCLE COST

Total budget authority represents the Life Cycle Cost (LCC). These figures include ELV costs.

Budget Authority ($ in millions)	Prior	FY02	FY03	FY04	FY05	FY06	FY07	FY08	BTC	Total	Comments
FY 2004 President's Budget (LCC)	72.3	66.9	33.5	6.2	5.3					184.2	
Development	72.3	66.9	33.5							172.7	
Operations				3.0	2.1					5.0	
Data Analysis				3.2	3.3					6.5	
Changes since FY 03 Pres. Budget		+9.9		+2.3	+2.3	-2.6				+11.9	***Reason for Change:***
Development		+9.9								+9.9	BAT instrument overrun.
Operations				+0.4	+0.2	-1.6				-1.1	
Data Analysis				+1.9	+2.2	-1.0				+3.1	
FY 2003 President's Budget (LCC)	72.3	57.0	33.5	3.9	3.0	2.6				172.3	
Development	72.3	57.0	33.5							162.8	
Operations				2.6	1.9	1.6				6.1	
Data Analysis				1.3	1.1	1.0				3.4	
Initial Baseline (LCC)	75.6	47.4	33.7	3.9	3.2	3.0				166.8	Launch 09/03.
Development	75.6	47.4	33.7							156.7	
Operations				2.6	1.9	2.0				6.5	
Data Analysis				1.3	1.3	1.0				3.6	

Indicates budget numbers in full cost.
Indicates changes since the FY 2003 President's Budget Submit.
FY 2002, FY 2003, Prior and BTC are not in full cost.

THEME: Structure and Evolution of the Universe (SEU)

DEVELOPMENT: Structure and Evolution of the Universe Small Development Projects

PURPOSE

Objectives	Reference 2003 Strategic Plan	Performance Measures
5.7, 5.8, 5.9, 6.1, 6.2, 6.3, 6.4, 7.1, 7.2		4SEU1,3,5,9-11,13-20

SEU Small Development Projects include relatively low-cost missions that pursue the objectives of the Theme. Herschel will solve the mystery of how stars and galaxies are born, while Planck will examine the first light that filled the universe after the Big Bang. Astro-E2 will investigate the creation of chemical elements, what happens when matter falls into black holes, and the heating of gas to X-Ray-emitting temperatures. GALEX will investigate star formation, the history of the Universe, and the evolution of galaxies and gas. CHIPS will study hot interstellar gas comparatively close to our Solar System, while SPIDR will study filaments of hot gas throughout the cosmos.

OVERVIEW

The missions in development that are included in SEU Small Projects are described below:

Herschel will be an infrared telescope used to study galaxy formation and evolution in the early Universe; the nature of active galaxy power sources; star forming regions and interstellar medium physics in the Milky Way and other galaxies. Herschel is led by the European Space Agency (ESA).

Planck will study the global characteristics of the Universe (age, composition, topology, etc.) by its precision all-sky measurement of the cosmic microwave background. Planck is led by the European Space Agency (ESA).

Astro-E2 is a Japanese x-ray astronomy mission, developed at the Institute of Space and Astronautical Science (ISAS) in collaboration with U.S. (NASA/GSFC, MIT) and Japanese institutions.

GALEX, the Galaxy Evolution Explorer, is a NASA UV imaging and spectroscopic survey mission designed to map the global history and probe the causes of star formation and evolution.

CHIPS will study the "Local Bubble," a tenuous cloud of hot interstellar gas surrounding our Solar System that extends about 300 light years from the Sun.

SPIDR will map the "cosmic web" of hot gas that spans the Universe. This will improve our understanding of the formation and evolution of large structures in the Universe.

PROGRAM MANAGEMENT

Astro-E2, GALEX, CHIPS, and SPIDR project responsibility is delegated to the Goddard Space Flight Center. Herschel and Planck project responsibility is delegated to the Jet Propulsion Laboratory. Enterprise official is Dr. Ed Weiler, Associate Administrator for Space Science at NASA HQ. The Theme Director and the Point of Contact is Dr. Anne Kinney, Director of the Astronomy and Physics Division at NASA HQ. These projects are in full compliance with NPG7120.5B.

TECHNICAL COMMITMENT

The technical commitment for each individual project is established in its Program Plan.

Technical Specifications	FY04 President's Budget	Change from Baseline
Herschel	700 hours science per year.	--
Planck	1 1/2 years mission life.	--
Astro-E2	detect X-rays with energies ranging from 0.4 to 700 keV.	--
GALEX	Pegasus XL launch, 28 month mission.	--
CHIPS	1-yr. mission to study hot interstellar gas.	n/a - UNEX mission
SPIDR	3-yr. mission to map "cosmic web" of hot gas.	n/a - new selection

Schedule	FY04 President's Budget	Change from Baseline
INTEGRAL	Launched successfully Oct. 17, 2002.	--
CHIPS	Launched successfully Jan. 12, 2003.	+5 months
GALEX	Launch March 2003	--
Astro-E2	Launch February 2005	--
SPIDR	Launch 2005	n/a - new selection
Herschel	Launch 2007	--
Planck	Launch 2007	--

THEME: Structure and Evolution of the Universe (SEU)

DEVELOPMENT: Structure and Evolution of the Universe Small Development Projects

ACQUISITION STRATEGY & PERFORMING ORGANIZATIONS

Herschel - ESA mission; launch on Ariane-5 with Planck.
Planck - ESA mission; launch on Ariane-5 with Herschel.
Astro-E2 - Japanese mission; launch from Japan, on an M-V (M-five) with a redesigned first stage.
GALEX - Explorer mission managed by GSFC; launch on Pegasus XL.

Current Acquisitions	Actual *	Selection Method	Actual *	Performer	Actual *
Cooperative Agreements	10%	Full & Open Competition	100%	Industry	40%
Cost Reimbursable	40%	Sole Source	%	Government	15%
Fixed Price	50%		100%	NASA Intramural	15%
Grants	0%			University	30%
Other	0%	Sci Peer Review	100%	Non Profit	
* as % of FY02 direct procurement	100%	* as % of FY02 direct procurement		* as % of FY02 direct procurement	100%

Future Acquisitions - Major	Selection	Goals
1. none - all major acquisitions are in place	n/a	n/a

AGREEMENTS

Internal: The program is not dependent on other NASA activities outside of the control of the Associate Administrator for Space Science. *External:* Herschel and Planck are ESA (European Space Agency) missions. Astro-E2 is a Japanese mission. **Changes since FY 2003 President's Budget: None.**

INDEPENDENT REVIEWS

Types of Review	Performer	Last Review	Next Review	Purpose
GALEX Pre Launch Review	NASA/GSFC	N/A	Jan. 2003	Final review prior to launch.

Projects led by our international partners (e.g. Herschel, Planck, Astro-2) are not normally subjected to U.S. independent reviews.

BUDGET/LIFE CYCLE COST

Budget authority represents the Development Cost, including launch services for NASA missions. Mission Operations and Data Analysis costs are budgeted elsewhere.

Budget Authority ($ in millions	Prior	FY02	FY03	FY04	FY05	FY06	FY07	FY08	BTC	Total	Comments
FY 2004 President's Budget		57.3	22.4	58.1	31.8	12.4	11.0				
INTEGRAL	10.1	1.3	0.5							11.9	
Herschel	37.7	13.5	15.4	11.8	6.0	6.4	6.0			96.7	
Planck	16.8	8.5	4.9	12.5	7.5	6.0	4.9			61.1	
Astro-E2		13.4		10.1	5.3					28.8	
CHIPS		6.4	1.5							7.9	
GALEX	73.2	13.9								87.1	
SPIDR		0.2		23.7	12.9					36.7	
JPL Support		0.1	0.1	0.1	0.1	0.1	0.1			0.6	
Changes since FY 03 Pres. Budget		-0.6		+45.9	+21.4	+0.1	+0.8			+67.6	***Reason for Change:***
Herschel		-1.1		+3.1	+0.2	+0.2	+0.2			+2.5	Instrument growth.
Planck		+3.7		+9.1	+3.0	-0.0	+0.6			+16.4	Cryocooler growth.
Astro-E2		+0.8		+10.1	+5.3					+16.2	04/05 requirements established.
CHIPS		-0.3								-0.3	
GALEX		-3.9								-3.9	
SPIDR		+0.2		+23.7	+12.9					+36.7	New Explorer mission
FY 2003 President's Budget		57.9	22.4	12.2	10.4	12.3	10.2				
INTEGRAL	10.1	1.3	0.5							11.9	
Herschel	37.7	14.6	15.4	8.7	5.8	6.2	5.8			94.2	
Planck	16.8	4.8	4.9	3.4	4.5	6.0	4.3			44.7	
Astro-E2		12.6								12.6	
CHIPS		6.7	1.5							8.2	
GALEX	73.2	17.8								91.0	
JPL Support		0.1	0.1	0.1	0.1	0.1	0.1				

Indicates budget numbers in full cost.
Indicates changes since the FY 2003 President's Budget Submit.

THEME: Structure and Evolution of the Universe (SEU)

OPERATIONS

PURPOSE

Objectives	Reference 2003 Strategic Plan	Performance Measures
5.7, 5.8, 5.9, 6.1, 6.2, 6.3, 6.4, 7.1, 7.2		4SEU4-12

Maximize the scientific return from NASA's investment in spacecraft and other data collection sources by conducting efficient and reliable operations of the data-collecting hardware which produces data that allow scientists to make new discoveries.

OVERVIEW

The following SEU missions are expected to be operating during FY 2004:

The **Rossi X-ray Timing Explorer (RXTE)** was launched into low-Earth orbit on December 30, 1995. RXTE observes the fast-moving, high-energy worlds of black holes, neutron stars, X-ray pulsars and bursts of X-rays.

NASA's **Chandra X-ray Observatory (CXO)** was launched and deployed by Space Shuttle Columbia on July 23, 1999. Chandra utilizes mirrors in conjunction with four science instruments to capture and probe X-rays from astronomical sources, such as the remnants of exploded stars.

The **High Energy Transient Explorer (HETE-2)** was launched 2000 October 9, and studies gamma ray bursts (GRBs) with ultraviolet, x-ray, and gamma ray instruments.

The **Microwave Anisotropy Probe (MAP)** was launched June 30, 2001. MAP will make a map of the temperature fluctuations of cosmic microwave background radiation (radiation left over from the Big Bang).

GALEX is scheduled for launch in early 2003 and will use an ultraviolet telescope during its two-year mission to explore the origin and evolution of galaxies and the origins of stars and heavy elements.

Gravity Probe B (GP-B) is currently scheduled for a summer 2003 launch. GP-B will test two predictions of Albert Einstein's general theory of relativity.

Swift Gamma Ray Burst Explorer is scheduled for a late 2003 launch. SWIFT will produce arcsecond positions and multiwavelength light curves for Gamma Ray Burst (GRB) afterglows.

Operations of **XMM-Newton** are provided by the European Space Agency.

For more information, link to Office of Space Science Missions homepage.
http://spacescience.nasa.gov/missions/index.htm

PROGRAM MANAGEMENT

Enterprise official is Dr. Ed Weiler, Associate Administrator for Space Science at NASA HQ. Theme Director and Point of Contact is Dr. Anne Kinney, Director of the Astronomy and Physics Division at NASA HQ. CXO is managed by the Marshall Space Flight Center. GP-B is managed by Stanford University. RXTE, HETE-2, MAP, GALEX, and Swift are managed by Goddard Space Flight Center. This program is in full compliance with NPG7120.5B.

TECHNICAL COMMITMENT

The baseline for all SEU missions is defined in their respective Program Commitment Agreements (PCAs) or equivalent documentation.

Technical Specifications	FY04 President's Budget	Change from Baseline
All missions will meet Level I specifications as identified in each mission's respective program plan.		--

Schedule	FY04 President's Budget		Change from Baseline
RXTE	Dec. 30, 1995 - TBD	Mission Extended	--
Chandra	July 23, 1999 - July 2009	Prime Mission	--
HETE-2	Oct. 9, 2000 - TBD	Mission Extended	--
MAP	June 30, 2001 - TBD	Prime Mission	--
GALEX	Early 2003 - TBD		--
GP-B	Late 2003; 16 Months of Ops		Launch delayed
Swift	Late 2003 - TBD		--

THEME: Structure and Evolution of the Universe (SEU)

OPERATIONS

ACQUISITION STRATEGY & PERFORMING ORGANIZATIONS

The prime contractor for Chandra operations is the Smithsonian Astrophysical Observatory (SAO). The contract for Chandra is being renewed in FY03 for a period of five years. XTE and MAP are operated by Lockheed Martin through the Consolidated Space Operations Contract (CSOC), which will be recompeted in late 2003. Lockheed Martin will also operate GALEX and Swift until after the recompetition. GP-B will be operated by Stanford University. In FY02, direct procurement represented 100% of budget authority. **Changes since FY03 Pres. Budget: None.**

Current Acquisitions	Actual *	Selection Method	Actual *	Performer	Actual *
Coop. Agrmts.	0%	Full & Open Competition	100%	Industry	33%
Cost Reimbursable	87%	Sole Source	0%	Government	
Fixed Price	13%		100%	NASA Intramural	5%
Grants	0%			University	0%
Other	0%	Sci Peer Review	100%	Non Profit	62%
* as % of FY02 direct procurement	100%	* as % of FY02 direct procurement		* as % of FY02 direct procurement	100%

Future Acquisitions - Major	Selection	Goals
1. CXO contract renewal	FY 03	Sole source with SAO.
2. CSOC recompetition	late 2003	100% Full & Open Competition.

AGREEMENTS

Internal: The program is not dependent on other NASA activities outside of the control of the Associate Administrator for Space Science. *External:* None. **Changes since FY03 Pres. Budget: None.**

INDEPENDENT REVIEWS

Types of Review	Performer	Last Review	Next Review	Purpose
Senior Review	External panel	June '02	Summer '04	To consider mission extensions and funding levels for operating SEU spacecraft that have completed their prime mission, based on science productivity and cost.

BUDGET

Budget Authority ($ in millions)	FY02	FY03	FY04	Comments
FY 2004 President's Budget	6.4	10.7	10.3	
Chandra	3.7	3.8	4.2	
RXTE	1.2	3.3	1.3	
MAP	1.2	1.4		
GP-B		2.0	1.1	
GLAST				
Swift			3.0	
SWAS	0.3			
GALEX		0.2	0.7	
Changes since FY 03 Pres.	-0.3		-0.2	***Reason for Change:***
Chandra			+0.6	Full cost.
RXTE			-2.0	Transferred to data analysis.
GP-B			+0.1	Full cost.
GLAST				Full cost plus launch delay.
Swift			+0.4	Full cost; FY 06 offset to Dev. Growth.
GALEX	-0.3		+0.7	Full cost plus launch delay.

Indicates budget numbers in full cost.
Indicates changes since the FY 2003 Presidents Budget Submit.
FY 2002 and FY 2003 are not in full cost.

THEME: Structure and Evolution of the Universe (SEU)

RESEARCH

PURPOSE

Objectives (Reference 2003 Strategic Plan)	Performance Measures
5.7, 5.8, 5.9, 6.1, 6.2, 6.3, 6.4, 7.1, 7.2	4SEU2, 4SEU13-20

The Research Program involves the study of cosmology (the large scale structure of the universe), the evolution of stars and galaxies (including the Milky Way and objects with extreme physical conditions), and an examination of the ultimate limits of gravity and energy in the Universe.

OVERVIEW

The SEU research program supports SEU Reseach and Analysis (R&A) and the analysis of data (DA) from the SEU operating missions, the provision of suborbital balloons for payloads that can use them to achieve their science objectives, and the science data tools and archives needed to perform the research. Data Analysis programs are tied to specific missions, which are focused on the achievement of specific strategic objectives. The scope of R&A programs is generally wider because they must provide the new theories and instrumentation that enable the next generation of flight missions. The alignment of Reseach programs with SEU strategic goals is ensured through two mechanisms. First, NASA Research Announcements soliciting R&A proposals contain explicit prioritization criteria with respect to Enterprise objectives. Second, the entire R&A program is reviewed triennially to assess scientific quality and productivity of the major components and to adjust plans to best support Enterprise goals. Data Analysis programs have traditionally been performed by mission instrument teams and interdisciplinary scientists competitively selected for an individual mission for the lifetime of that mission. The Data Analysis program also includes annual, open and competitive solicitations to all missions that can accommodate "guest investigations."

The Balloon program within the SEU theme area supports twenty plus missions a year and offers capabilities and benefits for scientific research that cannot be duplicated by other methods.

PROGRAM MANAGEMENT

NASA Headquarters is responsible for the SEU Research Program. Enterprise official is Ed Weiler, Associate Administrator for Space Science at Headquarters. Theme Director and point of contact is Anne Kinney, Director of the Astronomy and Physics Division at Headquarters. This program is in full compliance with NPG7120.5B.

TECHNICAL COMMITMENT

Baselines for research are consistent with those defined in individual Research Announcements released by the Office of Space Science. Data Analysis baselines are defined by the Program PCA or equivalent document.

Technical Specifications	FY04 President's Budget	Change from Baseline
Building on the FY 2003 NASA Strategic Plan, the OSS Strategic Planning process specifies a series of goals, strategic objectives and research focus areas. The OSS Strategic Plan draws from the Astronomy and Physics Decadal Survey (NRC), as well as the road mapping activities conducted by the Structure and Evolution of the Universe Subcommittee (SEUS). All selections processes and reviews of the elements of the SEU research program use these strategic items as guide posts for selection and/or continuation. Proposals for research must relate to these strategic items.		--

Schedule	FY04 President's Budget	Change from Baseline
R & A		
Research Opportunities In Space Science (ROSS)	Yearly in Feb.	--
Data Analysis		
Senior Reviews	Every Two Years	--
Balloon Program		
Research Opportunities In Space Science (ROSS)	Campaigns run all year	--

THEME: Structure and Evolution of the Universe (SEU)

RESEARCH

ACQUISITION STRATEGY & PERFORMING ORGANIZATIONS

The Research and Analysis (R&A), Data Analysis (DA) and Balloons programs make awards following peer reviewed competitions under NASA Research Announcements (NRAs), Announcements of Opportunity (AOs), and Cooperative Agreement Notices (CANs). The Balloon program has a prime contractor selected via competitive procurement through a Request for Proposals (RFPs). In FY 02, direct procurement represented 100% of budget authority. **Changes since FY 2003 President's Budget: None.**

Current Acquisitions	Actual *	Selection Method	Actual *	Performer	Actual *
Cooperative Agreements	5%	Full & Open Competition	98%	Industry	4%
Cost Reimbursable	32%	Sole Source	2%	Government	2%
Fixed Price	1%		100%	NASA Intramural	9%
Grants	49%			University	76%
Other	13%	Sci Peer Review	100%	Non Profit	9%
* as % of FY02 direct procurement	100%	* as % of FY02 direct procurement		* as % of FY02 direct procurement	100%

Future Acquisitions - Major	Selection	Goals
1. Annual R&A research announcement	Late 2003	100% Science Peer Review
2. Annual Chandra call for proposals	July 2003	100% Science Peer Review

AGREEMENTS

Internal: The program is not dependent on other NASA activities outside of the control of the Associate Administrator for Space Science.

External: Two missions in Data Analysis (XMM and INTEGRAL) involve agreements with the European Space Agency.

Changes since FY03 Pres. Budget: None.

INDEPENDENT REVIEWS

Types of Review	Performer	Last Review	Next Review	Purpose
MO&DA Senior Review	Sr. Review committee	June 2002	summer 2004	To recommend approval and funding level for extending the science investigations of the operating SEU missions.
R&A peer review	peer review committee	summer 2002	summer 2003	To review SEU proposals to the annual R&A announcement.

BUDGET

Budget Authority ($ in millions)	FY02	FY03	FY04	Comments
FY 2004 President's Budget (Research)	131.7	154.0	186.6	
R&A	25.6	27.0	28.6	
DA	92.1	113.0	132.7	
Balloons	14.0	14.0	25.3	
Changes since FY 03 Pres. Budget			+25.9	***Reason for Change:***
R&A			+0.7	Full cost
DA			+15.0	Full cost
Balloons			+10.2	Full cost; maintain flight rate

Indicates budget numbers in full cost.
Indicates changes since the FY 2003 Presidents Budget Submit.
FY 2002 and FY 2003 are not in full cost.

THEME: Structure and Evolution of the Universe (SEU)

TECHNOLOGY AND ADVANCED CONCEPTS

PURPOSE

Objectives	Reference 2003 Strategic Plan	Performance Measures
5.7, 5.8, 5.9, 6.1, 6.2, 6.3, 6.4, 7.1, 7.2		4SEU4, 4SEU7-9

The SEU Technology and Advanced Concepts effort develops advanced technologies needed for specific science missions. This process begins with mission studies - the first phase of the flight program development process. In this phase, scientists work collaboratively with technologists and mission designers to develop the most effective alignment of technology development programs with future mission requirements. This collaboration enables intelligent technology investment decisions through detailed analysis of the trade-offs between design considerations and cost.

OVERVIEW

SEU's Technology and Advanced Concept efforts are extremely diverse. The program works with and actively seeks input from scientists and engineers in academia, government, and industry. SEU follows an integrated strategy that coordinates technology development for different programs and leverages technology advancement to ensure a maximum return on investment. SEU has identified four technology areas that merit special attention, given their broad applicability across Enterprises. These areas are: Advanced Cryogenic Systems, Formation Flying, High Performance Optics, and Next Generation Detectors.

The **Laser Interferometer Space Antenna (LISA)** will consist of three spacecraft flying 5 million kilometers (km) apart in the shape of an equilateral triangle. The objective of LISA is to observe gravitational waves, including gravitational waves generated in the vicinity of the very massive black holes found in the centers of many galaxies. Some of the project's technology development areas include: inertial sensors, electrical discharge system to remove charges induced by cosmic rays, micro-newton thrusters, interferometry system, pointing accuracy to less than 10 nano-radian, and a high power laser.

Constellation-X (Con-X) is another example of how SEU is pushing the frontiers of technological advancement. Con-X will be a set of x-ray telescopes in space that work together to become 100 times more powerful than any previous x-ray telescope. Con-X will utilize two sets of extremely high performance X-ray telescope systems incorporating x-ray micro-calorimeters on each of four satellites; these instruments must be cooled to 50 millikelvins (a fraction of a degree above absolute zero) by cryogenic coolers.

The President's Budget Request for FY 2004 includes increased funding for LISA and Con-X as part of a new initiative called "Beyond Einstein." Beyond Einstein is critical to achieving Objectives 5.7 and 5.8 of the NASA Strategic Plan, to discover what powered the Big Bang and the nature of the mysterious dark energy that is pulling the Universe apart; and to learn what happens to space, time, and matter at the edge of a black hole. LISA and Con-X are the first elements in Beyond Einstein, and are planned for launch early next decade. The initiative will eventually include a series of fully competed, moderate-sized, scientist-led missions to be known as Einstein Probes, to be launched about once every three years.

PROGRAM MANAGEMENT

The program responsibility is being managed at NASA HQ. The Program Management Council (PMC) has governing responsibility. Each SEU mission will execute the NASA formulation sub-process per NPG 7120.5B to provide high confidence that it will be ready to proceed into implementation. Enterprise official is Dr. Edward Weiler, Associate Administrator for Space Science at NASA HQ. Theme Director and Point of Contact is Dr. Anne Kinney, Director of the SEU Program at NASA HQ.

TECHNICAL COMMITMENT

Project technical baselines are defined by the individual Formulation Authorization Document (FAD), Program Commitment Agreement (PCA) or equivalent documentation. In anticipation of entering the Formulation phase, a FAD for LISA will be completed during the summer of 2003. A FAD for Con-X will be completed about 3yrs later.

Technical Specifications	FY04 President's Budget	Change from Baseline
LISA	TBD - Will be established in the FAD	N/A
CON-X	TBD - Will be established in the FAD	N/A

THEME: Structure and Evolution of the Universe (SEU)

TECHNOLOGY AND ADVANCED CONCEPTS

TECHNICAL COMMITMENT - CONTINUED

Schedule	FY04 President's Budget	Change from Baseline
LISA		
Formulation Start	FY03	no established baseline until confirmation
PDR	TBD	no established baseline until confirmation
Implementation Start	TBD	no established baseline until confirmation
CDR	TBD	no established baseline until confirmation
Launch	TBD	no established baseline until confirmation
Con-X		
Formulation Start	TBD	no established baseline until confirmation
PDR	TBD	no established baseline until confirmation
Implementation Start	TBD	no established baseline until confirmation
CDR	TBD	no established baseline until confirmation
Launch	TBD	no established baseline until confirmation

ACQUISITION STRATEGY & PERFORMING ORGANIZATIONS

The LISA Project Management Office is jointly managed by NASA (GSFC and JPL) and ESA, with NASA having the lead for the day-to-day activity. Responsibility for LISA's mission success is jointly shared between NASA and ESA at all levels. CON-X is being managed solely out of GSFC. In FY02, direct procurement represented 100% of budget authority. **Changes since FY 2003 President's Budget: None.**

Current Acquisitions	Actual *	Selection Method	Actual *	Performer	Actual *
Cooperative Agreements	8%	Full & Open Competition	61	Industry	10%
Cost Reimbursable	24%	Sole Source	39	Government	16%
Fixed Price	10%		100%	NASA Intramural	39%
Grants	0%			University	27%
Other	58%	Sci Peer Review	100%	Non Profit	8%
* as % of FY02 direct procurement	100%	* as % of FY02 direct procurement		* as % of FY02 direct procurement	100%

Future Acquisitions - Major	Selection	Goals
1. LISA Phase A Study contracts	FY 04	100% Full & Open Competition, 100% Fixed Price

THEME: Structure and Evolution of the Universe (SEU)

TECHNOLOGY AND ADVANCED CONCEPTS

AGREEMENTS

Internal: The program is not dependent on other NASA activities outside of the control of the Associate Administrator for Space Science.

External: LISA currently has a LOA with the European Space Agency (ESA).

Changes since FY03 Pres. Budget: None.

INDEPENDENT REVIEWS

Types of Review	Performer	Last Review	Next Review	Purpose
Con-X / LISA Independent Implementation Review	IRT/IPAO	n/a	Mar-03	To assure compliance with defined technical, cost and schedule thresholds (PCA's, Roadmaps).

BUDGET

Budget Authority ($ in millions)	FY02	FY03	FY04	Comments
5.9.1	13.0	21.5	60.9	
CON-X	6.4	12.8	23.5	New Initiative - includes Beyond Einstein funding.
LISA	6.2	7.3	35.4	New Initiative - includes Beyond Einstein funding.
Einstein Probes				New Initiative - part of Beyond Einstein (funding begins in FY 2007).
Other	0.4	1.4	2.0	
Changes since FY 03 Pres. Budget				
CON-X			-2.2	New Initiative - includes Beyond Einstein funding.
LISA			+22.2	New Initiative - includes Beyond Einstein funding.
Einstein Probes				New Initiative - part of Beyond Einstein (funding begins in FY 2007).
Other				

Indicates budget numbers in full cost.

Indicates changes since the FY 2003 Presidents Budget Submit.

FY 2002 and FY 2003 are not in full cost.