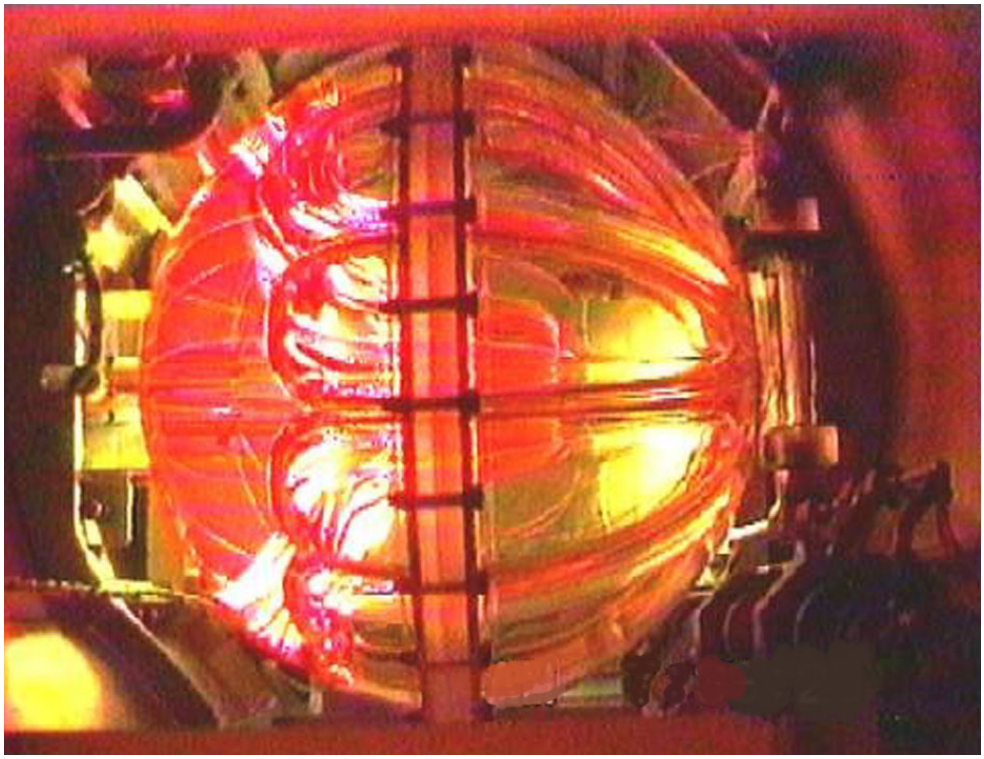
Theme: Physical Sciences Research



Liquid at rest in a transparent spherical tank under low gravity shows one aspect of the surprising behavior of fluid systems in space.

Physical Sciences Research

MAJOR EVENTS IN FY 2005

All Physical Sciences Research (PSR) major events listed below will be accomplished **pending the Exploration Replanning**.

- PSR will complete three (3) Microgravity Science Glovebox experiments.
- PSR will initiate Advanced Life Support research flight experiment development.
- PSR will initiate design an In-space Fabrication and Repair experiment.
- PSR will publish STS-107 research results together with International Space Station (ISS) flight experiments.

Theme: Physical Sciences Research

OVERVIEW

PENDING EXPLORATION REPLANNING. The Office of Biological and Physical Research (OBPR) Physical Sciences Research (PSR) theme carries out basic and applied scientific investigations to lay the foundation for understanding the details of physical and chemical processes involved in developing the capabilities to deploy spacecraft, to generate resources, and to maintain life support sub-systems for in-space and planetary applications. By using the unique environment afforded by space platforms, the program also tackles fundamental unsolved scientific problems and pursues a better understanding of processes sensitive to the effects of gravity and relevant to industrial and technological applications on Earth. This theme relies on a talented and diverse academic research community to carry out many of its research activities, strives to involve the next generation of scientists and engineers in space-based, as well as Earth-based, theoretical and experimental research, and to communicate the excitement and share the rewards of new discoveries. (Note: PSR will be conducting a major review of priorities to ensure alignment of activities with the new Exploration vision. Some of the specific activities described here may change.)

Missions	Goals supported by this Theme	Objectives supporting these Goals
To Understand and Protect Our Home Planet	3. Create a more secure world and improve the quality of life by investing in technologies and collaborating with other agencies, industry, and academia.	3.2 Improve the Nation's economic strength and quality of life by facilitating innovative use of NASA technology.
		3.3 Resolve scientific issues in the low gravity environment of space that enrich life on Earth by leading to better design tools in energy, materials, medical, and communication technologies.
To Explore the Universe and Search for Life	4. Explore the fundamental principles of physics, chemistry, and biology through research in the unique natural laboratory of space.	4.2 Expand understanding of fundamental physical processes and insight into the laws of nature through space-based investigation.
Exploration Capabilities	9. Extend the duration and boundaries of human space flight to create new opportunities for exploration and discovery.	9.2 Develop new human support systems and solutions to low gravity technological challenges to allow the next generation of explorers to go beyond low earth orbit.

RELEVANCE

The PSR theme addresses high priority research as identified by the science community. The PSR theme improves the design and operation of space-based infrastructure such as spacecraft power and propulsion sub-systems, life support and resource creation and management systems, and innovative fabrication methods for space exploration purposes either in-space or on extra-terrestrial locations. Data from PSR projects will enable new technologies or improve existing designs in: 1) efficient technologies for thermal management relying on boiling (an apparently simple technology not now available to designers because boiling in low gravity is not well-understood) two-phase flows in low-gravity in order to improve heat rejection capacity and reliability while decreasing mass and volume requirements; 2) materials flammability assessment, combustion detection sensors, and fire extinguishment methodologies development in low and partial gravity; 3) novel approaches for in-space fabrication methods using limited resources, under varying gravity levels, pressures and temperatures.; and 4) the development of radiation protection structure technology. At the same time, this research seeks to improve Earth-based science and technologies in a range of disciplines: combustion, fluids, materials, biophysics, structural biology, and fundamental physics and chemistry.

Education and Public Benefits
Public benefits are derived from the accumulation of new knowledge on a variety of physical and chemical phenomena that cannot be understood, or even observed, by Earth-based experiments because of the effects of gravity. A better understanding of how combustion, free convection, and other phenomena will lead to better manufacturing processes and improved products. With consistent improvements and a continued understanding of these effects, their positive impacts to our quality of life is evident. The broadly-based nurturing of academic peer-reviewed research through undergraduate, graduate, and post-doctoral students support in a wide variety of scientific and engineering disciplines will contribute to sustain the supply of the skilled technical workforce of tomorrow. New observations and understanding of nature revealed by unfamiliar phenomena by scientific research in space will enhance the appeal of a technical education. They will provide the renewed excitement and motivation to acquire understanding and to make new discoveries through actual hands-on involvement in flight-based research and space exploration.

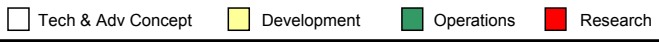
IMPLEMENTATION

The Enterprise Official for the Physical Sciences Research Theme is Mary Kicza, Associate Administrator for Biological & Physical Research. The HQ Division Director for Physical Sciences Research is Dr. Eugene Trinh. PSR is a multiple project and single program theme with program responsibility in the Office of Biological and Physical Research at NASA HQ. This theme is composed of a set of integrated elements working together to achieve the aforementioned goals and objectives. Those elements support five scientific and engineering disciplines contributing their expertise to the accomplishment of the specified goals and objectives. These disciplines are: Cellular and Macromolecular Biotechnology, Combustion Science, Fluid Physics and Transport Phenomena, Materials Science, and Fundamental Physics. Each of these disciplines involve the related scientific communities in academia, government, and the private sector who compete

for peer-reviewed research grants to carry out earth and space-based research. The flight-based research is carried out through the development, on-orbit deployment, and operations of a set of cross-disciplinary and/or specialized facilities. The output of the earth and space-based research takes the form of peer-reviewed archival publications, patents, students master and doctoral theses, co-operative agreements with the private sector for collaborative research or for product development, and transferred technology through a technical database. The elements of the program include a Research component that selects and administers peer reviewed research grants and contracts, and a flight research element that controls the International Space Station (ISS) and the Shuttle development and operations activities. The ISS flight program is developing the following set of specialized and cross-disciplinary research facilities: The Biotechnology Facility (BTF) that will be housed in multi-purpose Express racks, the Fluids and Combustion Facility (FCF - currently composed of the Fluids Integrated Rack (FIR) and Combustion Integrated Rack (CIR)), the Materials Science Research Rack (MSRF - currently composed of MSRR-1), the Low Temperature Microgravity Physics Facility (LTMPF) on the external payload facilities, and a series of pressurized environment sub-rack apparatuses (e.g., Physics of Colloids in Space (PCS)). Progress toward accomplishing Annual Performance Goals will be assessed by an advisory committee.

IMPLEMENTATION SCHEDULE

Theme Element	Schedule by Fiscal Year 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10	Purpose
Combustion Integrated Rack (CIR)		Flight-based research facility for fundamental research in energy and pollutant production processes and spaceflight fire safety issues.
Microgravity Science Glovebox Research & Development		Low-gravity laboratory facility for real-time astronaut interaction.
Materials Science Research Rack 1 (MSRR-1)		Materials science facility for understanding of the diverse forms of matter, materials manufacturing and development for space-based systems.
Fluids Integrated Rack (FIR)		Perform investigations in fundamental fluid flows in physiological phenomena, and to develop a scientific data base.
Low-Temperature Microgravity Physics Facility (LTMPF)		Remotely-controlled facility to test fundamental laws of condensed matter physics and to develop ultra-precise atomic clocks.
Biotechnology Research Facility (BTF)		Consolidated facility to perform cell assembling and tissue culturing research.



Full compliance with NPR 7120.5B will be achieved in FY04 for the relevant portions.

STATUS

The PSR theme carried out numerous research investigations on STS (Space Transportation System)-107 related to three-dimensional tissue growth, fluid viscosity, granular materials, laminar soot, flame ball structure, and fire behavior. PSR initiated the Space Radiation Shielding Program, aimed at developing radiation shielding appropriate for long-duration lunar or Mars missions and validated a 50-year-old hypothesis explaining how liquid metals resist turning in to solids using the Electrostatic Levitator. PSR also completed ISS Microgravity Glovebox research investigation on colloidal physics and initiated materials science research on particle growth in liquids. Other achievements included: investigated fundamental and unresolved issues in condensed matter physics and atomic physics, and carried out atomic clock development for space-based utilization; designed and developed flight experiment apparatus for low-temperature physics, laser cooling, and atomic physics investigations on the ISS; and selected 35 ground research proposals in the first-half of CY 2003. Please follow this link for additional data: http://spaceresearch.nasa.gov/.

PERFORMANCE MEASURES

Outcomes/Annual Performance Goals (APGs)	
Outcome 3.2.5	*By 2008, increase by 30% (from the 2003 level) the utilization of NASA/OBPR-derived technologies by other agencies, private sector, and academia to advance basic and applied research goals of practical impact.*
5PSR1	Develop a multi-agency collaboration for research at the interface between the physical and life sciences, and enhance collaborative efforts with other agencies and the private sector on biotechnology, materials research, and optical diagnostics for health research.
Outcome 3.3.1	*By 2008, analyze the impact of the results of the first phase of ISS and ground-based research in Biotechnology, fundamental science, and engineering to demonstrate the introduction of at least two new design tools and/or process improvements to existing technologies and industrial practices.*
5PSR2	Continue a productive ground and flight-based research program in Combustion, Fluid Physics, Biotechnology, and Materials science, and carry out the milestones for all ISS research projects.
Outcome 3.3.2	*By 2008, quantitatively assess the impact of space and ground-based research on fire safety hazard prevention and*

Theme: Physical Sciences Research

Outcomes/Annual Performance Goals (APGs)	
	containment and on energy conversion to demonstrate measurable risk reduction and increased efficiency.
5PSR3	Publish the results of STS-107 investigations based on available data in microgravity combustion research, and maintain a productive ground and flight-based program in fundamental and strategic combustion and reactive flows research.
Outcome 4.2.1	*By 2008, complete the first generation of ISS research in colloidal physics and soft condensed matter and demonstrate the ability to control the colloidal engineering of at least two different model structures.*
5PSR4	Continue flight and ground-based research in colloidal physics and soft-condensed matter, and accomplish the project milestones for the ISS research program in fluid physics.
Outcome 4.2.2	*By 2008, complete the design and fabrication of the first ISS fundamental microgravity physics facility to allow the performance of two capstone investigations in dynamical critical phenomena.*
5PSR5	Continue the development of the ISS fundamental physics facility for low temperature and condensed matter physics, and maintain a productive ground-based research program in condensed matter physics.
Outcome 4.2.3	*By 2008, complete the design for the ISS laser-cooling laboratory and demonstrate the feasibility to deploy the most accurate atomic clock in space.*
5PSR6	Continue the development of the ISS laser cooling and atomic facility by accomplishing the project milestones, and maintain an innovative and outstanding ground research program in atomic and gravitational physics.
Outcome 4.2.4	*By 2008, complete the first phase of the ISS biotechnology facility and demonstrate cellular biotechnology research throughput increase by a factor of two.*
5PSR7	Continue the development of the ISS Biotechnology Facility and maintain a productive and innovative ground and space research program in cellular biotechnology and tissue engineering.
Outcome 9.2.2	*By 2008, develop predictive models for prototype two-phase flow and phase change heat transfer systems for low- and fractional gravity with an efficiency improvement of at least a factor of two over 2003 ISS radiative systems, and prepare ISS experiments for validation.*
5PSR8	Continue Strategic ground-based research in microgravity heat-exchange multi-phase systems and advance existing flight projects toward flight.
Outcome 9.2.3	*By 2008, develop predictive engineering model and prototype systems to demonstrate the feasibility of deploying enhanced space radiation-shielding multi-functional structures with at least a factor of two improvement in shielding efficiency and mass reduction, and prepare a space experiment for validation.*
5PSR9	Continue accumulating data on radiation effects on materials properties and initiate the assessment of the performance of multifunctional materials.
Uniform Measures	
5PSR10	Complete all development projects within 110% of the cost and schedule baseline.
5PSR11	Deliver at least 90% of scheduled operating hours for all operations and research facilities.
5PSR12	At least 80%, by budget, of research projects will be peer-reviewed and competitively awarded.

INDEPENDENT REVIEWS

Review Types	Performer	Last Review Date	Next Review Date	Purpose
ReMAP	Independent Committee	9/02	N/A	Set priorities for ISS Research
National Research Council Committees	NAS/NRC	6/02	N/A	NAS research progress/quality
External Advisory Committees-BPRAC	NASA	8/02	2/04	Advisory Committees Research

BUDGET

Budget Authority ($ millions)	FY 2003	FY 2004	Change	FY 2005	Comments
Physical Sciences Research	**241.4**	**357.2**	**-57.1**	**300.1**	**Pending Exploration Replanning**
Development	48.9	47.5	-13.8	33.7	
Materials Science Research Rack-1 (MSRR-1)	8.8	15.0	-7.5	7.5	
Fluids and Combustion Facility (FCF)	29.7	22.8	-5.8	17.0	
Low Temperature Microgravity Physics Facility (LTM)	10.4	9.7	-0.5	9.2	
Operations	102.3	158.4	-51.4	107.0	
Research	90.1	151.3	+8.1	159.4	

Indicates changes since the previous year's President's Budget Submit

Indicates budget numbers in full cost.

Theme: Physical Sciences Research
Development: Fluids and Combustion Facility (FCF)

PURPOSE

Objectives	Performance Measures
3.2, 3.3, 4.2, 9.2	5PSR1-10

PENDING EXPLORATION REPLANNING. The primary purpose of the Fluids and Combustion Facility (FCF) is to use the space environment as a laboratory to test the fundamental principles of physics, chemistry, and biology and to generate the required scientific microgravity database to enable the development of technologies for human space exploration beyond LEO. (Note: PSR will be conducting a major review of priorities to ensure alignment of activities with the new Exploration vision. Some of the specific activities described here may change.)

OVERVIEW

The Fluids Integrated Rack (FIR) is an ISS science rack designed to study the properties of simple and complex fluids in various forms (i.e. liquid, gas, multi-phase mixture) in an orbital microgravity environment. The objective is to remove the effects of sedimentation, buoyancy, and convection in order to investigate natural phenomena and industrial processes and systems that are greatly affected by gravitational forces. The FIR provides the laboratory infrastructure to carry out detailed observations and accurate measurements by implementing an ingenious and award-winning rotatable optical bench that allows the quick removal and installation of experiment containers and various diagnostic instrumentation such as imaging, confocal microscopy, environment control, and automation. The Combustion Integrated Rack (CIR) provides similar research capability for investigations requiring insight into the behavior of laminar flames, turbulent droplet and spray combustion, and flame spread over fuel surfaces when the influence of gravity is greatly reduced. Both racks allow the implementation of many different investigations because of their modular design that is conducive to the use of a variety of experimental inserts to accommodate a wide range of research topics.

Please follow this link for additional data: http://fcf.grc.nasa.gov/.

PROGRAM MANAGEMENT

The Enterprise Official for the Physical Sciences Research Theme is Mary Kicza, Associate Administrator for Biological & Physical Research. The HQ Division Director for Physical Sciences Research is Dr. Eugene Trinh. The FCF program responsibility is delegated to the Glenn Research Center. Project Manager is Robert Zurawski at the Glenn Research Center. FCF Development is being implemented per ISSRC Program Commitment Agreement (PCA) dated July 9, 2003.

TECHNICAL COMMITMENT

PENDING EXPLORATION REPLANNING. FCF Development is being implemented per ISSRC Program Committement Agreement (PCA) dated July 9, 2003.

Technical Specifications	FY 2005 President's Budget	Change from Baseline
Launch Vehicle:	Shuttle	--
Fluids and Combustion Facility:	1 FIR / 1 CIR	--
Power to Payloads:	3 kW rack power	--
Facility operational lifetime:	10 years	--
Operational capability:	Provides gas mixing, thermal control, data storage, power conditioning and digital imaging	--
Science Instruments:	Gas Chromatograph, Infrared Imaging, Fiber Illumination, Optics Bench and a High-Pressured Containment Vessel	--

Schedule	FY 2005 President's Budget	Change from Baseline
CIR Critical Design Review (CDR)	May-02	+2 months
FIR Critical Design Review (CDR)	Dec-02	+2 month
CIR Flight Hardware Available (FHA)	Oct-04	+3 Months
FIR Flight Hardware Available (FHA)	Dec-04	+4 Months

ACQUISITION STRATEGY AND PERFORMING ORGANIZATIONS

Major acquisitions for FCF are: Power Supply, Avionics/control, Common illumination, PI Integration optics bench, Fluid diagnostics, Environmental Control, Imaging and frame capture, Combustion Diagnostics, Combustion Chamber with Northop Grumman as the prime contractor. Changes since FY04 President's Budget: None.

Theme: Physical Sciences Research
Development: Fluids and Combustion Facility (FCF)

Current Acquisition	Actual*	Selection Method	Actual*	Performer	Actual*
Cooperative Agreement	0%	Full & Open Competition	90%	Industry	89%
Cost Reimbursable	0%	Sole Source	10%	Government	4%
Fixed Price	42%		100%	NASA Intramural	6%
Grants	0%			University	1%
Other	58%	Sci Peer Review	0%	Non Profit	0%
* as of FY03 direct procurement	100%	* as of FY03 direct procurement		* as of FY03 direct procurement	100%

Future Acquisition - Major	Selection	Goals
Change to Cost Plus	Fall 03	100% Full & Open Competition, 10% SB, 100% Cost Plus

AGREEMENTS

Internal: None. External: None. Changes since the FY04 Presidents Budget: None.

RISK MITIGATION

Risk Date: 1/15/2004

Top Risks	G	Overall	G	Cost	Y	Schedule	G	Technical	Probability	Impact	Mitigation Plan
Y	Verification Program								Low	Low	In Place

INDEPENDENT REVIEWS

Review Types	Performer	Last Review Date	Next Review Date	Purpose
Critical Design Reviews	Indep. Panel	9/03	N/A	NASA technical and programmatic assessment.
ReMAP	Independent Committee	9/02	N/A	Set priorities for ISS Research.

BUDGET/LIFE CYCLE COST

Budget Authority ($ millions)	Prior	FY03	FY04	FY05	FY06	FY07	FY08	FY09	BTC	Total Comments
FY2005 PRESBUD	136.2	29.7	22.8	17.0	10.8					216.5
Development	136.2	29.7	22.8	17.0	10.8					216.5
Changes since 2004 PRESBUD	+6.4	+17.7	-0.1	+4.5	+5.9					+34.4
Development	+6.4	+17.7	-0.1	+4.5	+5.9					+34.4
FY2004 PRESBUD	129.8	12.0	22.9	12.5	4.9					182.2
Development	129.8	12.0	22.9	12.5	4.9					182.2
Initial Baseline		12.0	22.9	12.5	4.9					52.3
Fluids and Combustion Facility (FCF)		12.0	22.9	12.5	4.9					52.3

Indicates changes since the previous year's President's Budget Submit
Indicates budget numbers in full cost.

Theme: Physical Sciences Research
Operations: Low Temperature Microgravity Physics Facility (LTMPF)

PURPOSE

Objectives	Performance Measures
4.2	5PSR4-7,10

PENDING EXPLORATION REPLANNING. The Low Temperature Microgravity Physics Facility (LTMPF) will use the space environment as a laboratory to test the fundamental principles of physics, chemistry, and biology. LTMPF will allow the scientific community to carry out definitive experiments in condensed matter physics and critical phenomena. The currently selected space-based investigations are considered capstone research, offering groundbreaking opportunities not before available. (Note: PSR will be conducting a major review of priorities to ensure alignment of activities with the new Exploration vision. Some of the specific activities described here may change.)

OVERVIEW

The Low Temperature Microgravity Physics Facility (LTMPF) is an external unpressurized payload. The LTMPF is designed for long-duration science investigations whose objectives can only be achieved in a microgravity environment and at ultra-low temperatures provided by a space-qualified cryogenic dewar system. The facility will allow automated and remotely-commanded unique experimental apparatuses operated at near absolute zero temperature and implementing stable high resolution thermometry. The combination of low-gravity and the use of this high-precision instrumentation will allow the accurate measurement of fundamental parameters such as the heat capacity and compressibility in the critical region of superfluid helium. Such measurements are required to verify fundamental theoretical predictions, but are impossible to carry out on Earth. LTMPF will also lead to the development of on-orbit super-stable microwave cavity and to the implementation of a novel Laser Cooling and Atomic Physics facility for the development of ultra-precise atomic clocks.

PROGRAM MANAGEMENT

The Enterprise Official for the Physical Sciences Research Theme is Mary Kicza, Associate Administrator for Biological & Physical Research. The HQ Division Director for Physical Sciences Research is Dr. Eugene Trinh. The LTMPF Project program responsibility is delegated to the Jet Propulsion Laboratory. Project Manager is John Pensinger at the Jet Propulsion Laboratory. LTMPF Development is being implemented per ISSRC Program Commitment Agreement (PCA) dated July 9, 2003.

TECHNICAL COMMITMENT

PENDING EXPLORATION REPLANNING. LTMPF Development is being implemented per ISSRC Program Commitment Agreement (PCA) dated July 9, 2003.

Technical Specifications	FY 2005 President's Budget	Change from Baseline
Launch Vehicle	Shuttle	--
External attached payload	Attached payload located on Japanese Module	--
Power to Payloads	300 W power	--
Facility operational lifetime	10 years (5 missions of 6 months each, every 22 months)	--
Operational capability:	5-6 months of Helium and 4.5 months Data Acquition per mission	--
Science Instruments:	Critical Dynamics in Microgravity (DYNAMX/CQ) and Superconducting Microwave Oscillator Experiment (SUMO)	--

Schedule	FY 2005 President's Budget	Change from Baseline
LTMPF Critical Design Review (CDR)	Sep-03	+3 months
LTMPF Final Assembly and Test (FAT)	May-06	--
LTMPF Flight Hardware Available (FHA)	Aug-07	+18 months

ACQUISITION STRATEGY AND PERFORMING ORGANIZATIONS

Major acquisitions for LTMPF are: Facility (includes dewar, enclosure, common electronics & software), Dewar (provides cryostat) and Probe (houses two ISP's). Ball Aerospace and Technology Corporation (BATC) selected in 1995 as prime contractor. In 2001 BATC's content was descoped to only provide the Dewar and Enclosure Subsystem (DES) and Deign_Net Engineering was selected to provide Electronics and Software Subsystem (ESS). Changes since the FY04 President's Budget: None.

Theme: Physical Sciences Research
Operations: Low Temperature Microgravity Physics Facility (LTMPF)

Current Acquisition	Actual*	Selection Method	Actual*	Performer	Actual*
Cooperative Agreement	0%	Full & Open Competition	100%	Industry	100%
Cost Reimbursable	0%	Sole Source	0%	Government	0%
Fixed Price	0%		100%	NASA Intramural	0%
Grants	0%			University	0%
Other	100%	Sci Peer Review	0%	Non Profit	0%
* as of FY03 direct procurement	100%	* as of FY03 direct procurement		* as of FY03 direct procurement	100%

Future Acquisition - Major	Selection	Goals
Cost + Award Fee	Fall 01	100% Full & Open Competition, 10% SB, 100% Cost Plus Award Fee

AGREEMENTS

Internal: None External: Payload Interface Unit (PIU), Flight Releasable Attachment Mechanism (FRAM), Flight Releasable Grapple Fixture (FRGF) and H Fixture from NASA JSC and SAMS accelerometer from NASA GRC. Changes since FY04 President's Budget: None.

RISK MITIGATION

Risk Date: 1/15/2004

Top Risks	G	Overall	Y	Cost	G	Schedule	Y	Technical	Probability	Impact	Mitigation Plan
Y	Frequency - Synchronization link implementation approach to be agreed to by JAXA.								moderate	moderate	under development

INDEPENDENT REVIEWS

Review Types	Performer	Last Review Date	Next Review Date	Purpose
Independent Assessment	MSFC CFO	7/01	N/A	Cost and schedule assessment.
ReMap	Independent Committee	9/02	N/A	Set priorities for ISS research

BUDGET/LIFE CYCLE COST

Budget Authority ($ millions)	Prior	FY03	FY04	FY05	FY06	FY07	FY08	FY09	BTC	Total	Comments
FY2005 PRESBUD	40.0	10.4	9.7	9.2	7.3	4.5	2.0	2.1		85.3	
Development	40.0	10.4	9.7	9.2	7.3	4.5	2.0	2.1		85.3	
Changes since 2004 PRESBUD	+11.6	-2.5	-0.1	+2.8	+6.0	+4.5	+2.0	+2.1		+26.4	
Development	+11.6	-2.5	-0.1	+2.8	+6.0	+4.5	+2.0	+2.1		+26.4	
FY2004 PRESBUD	28.4	12.9	9.8	6.4	1.3					58.9	
Development	28.4	12.9	9.8	6.4	1.3					58.9	
Initial Baseline		12.9	9.9	6.4	1.3					30.5	
LowTemp Microgr Physics Facility (LTMPF)		12.9	9.9	6.4	1.3					30.5	

Indicates changes since the previous year's President's Budget Submit
Indicates budget numbers in full cost.

Theme: Physical Sciences Research
Development: Materials Science Research Rack – 1(MSRR-1)

PURPOSE

Objectives	Performance Measures
3.2, 3.3, 4.2, 9.2	5PSR1-10

PENDING EXPLORATION REPLANNING. The strategic objective of the Materials Science Research Rack-1 is to use the space environment as a laboratory to test the fundamental principles of physics, chemistry, and biology. The fundamental purpose of the MSRR-1 will be to evaluate the reactions of various materials to a low gravity environment while contained in a specialized compartment. (Note: PSR will be conducting a major review of priorities to ensure alignment of activities with the new Exploration vision. Some of the specific activities described here may change.)

OVERVIEW

The MSRR-1 is a modular autonomous rack that implements a set of furnace modules and diagnostic instrumentation for the study of a variety of materials such as glass, ceramics, metals and alloys, electronic materials, and composites in a low gravity environment. The MSRR-1 includes subsystems that provide basic resources, and experiment modules and module inserts, which contain the scientific experiments. An Active Rack Isolation System (ARIS) is provided for vibration isolation. The MSRR-1 accommodates the Materials Science Laboratory through a cooperative project with the European Space Agency. A second experiment module is provided through the Space Products Development program.

Please follow this link for additional data: http://msrf.msfc.nasa.gov/index.html

PROGRAM MANAGEMENT

The Enterprise Official for the Physical Sciences Research Theme is Mary Kicza, Associate Administrator for Biological & Physical Research. The HQ Division Director for Physical Sciences Research is Dr. Eugene Trinh. The MSRR Project is delegated to the Marshall Space Flight Center (MSFC). Project Manager is Charles Darby at MSFC. MSRR-1 Development is being implemented per ISSRC Program Commitment Agreement (PCA) dated July 9, 2003.

TECHNICAL COMMITMENT

PENDING EXPLORATION REPLANNING. MSRR-1 Development is being implemented per ISSRC Program Commitment Agreement (PCA) dated July 9, 2003.

Technical Specifications	FY 2005 President's Budget	Change from Baseline
Launch Vehicle	Shuttle	--
MSRR-1	1 MSRR rack, 1 Quench Module Insert (QMI) insert, and 1 SPD furnace module accommodation	--
Power to Payloads	3 kW rack power	--
Operational capability:	Provides support for 2 Experiment Modules Processing, parameters can be updated or changed through telescience control of the payload. Sample exchange is manual.	--
ARIS equipped ISPR	Major support subsystems: Master Controller, Solid State Power Control Module, Thermal and Environmental Control System, Vacuum Access System, Support Structure, Experiment Modules and Module Inserts.	--
Science Instruments: Materials Science Laboratory EM	Support precise temperature stability and control, high resolution temperature resolution and measurement, furnace translation capability, mass spectrometer failure detection system, rotating magnetic field, current pulsing capability for sample interface demarcation, and shear cell motor drive capability. Module Inserts Quench Module Insert (QMI) Large Gradient Furnace (LGF) & Solidification Quench Furnace (SQF) are exchangeable on-orbit for tailored experiment conditions including high temperature processing with high and low temperature gradients, rapid heat extraction through quenching, and isothermal heated regions.	--
Science Instruments: Space Product Development EM	Supports on-orbit exchange of transparent and opaque furnace inserts for vapor crystal growth and processing of glass performs. Samples are exchanged with furnace inserts. Provides temperature control and telescience monitoring and control of processing parameters.	--

Theme: Physical Sciences Research
Development: Materials Science Research Rack – 1(MSRR-1)

Schedule	FY 2005 President's Budget	Change from Baseline
Integrated Payload CDR	Complete 5/02	--
Payload Safety Review	Oct-03	--
Growth and processing of glass preforms. Samples are exchanged w/ furnace insert	Jan-05	+6 months
MSRR Flight Hardware Available (FHA)	July-05	+6 Months

Acquisition Strategy and Performing Organizations

Major acquisitions for MSRR - 1 are: Solid State Power Control Module (SSPCM), Active Rack Isolation System (ARIS), and International Standard Payload Rack (ISPR). The Quench Module Insert (QMI) and additional Rack Support Systems (RSS) which consist of the Master Controller (MC), Thermal & Environment Control System, Vacuum Access System and Support Structure are developed and acquired through the in-house effort. The Materials Science Laboratory Experiment Module (MSL-EM), Space Product Development - Experiment Module (SPD-EM) are acquired through other agreements. Changes since the FY04 President's Budget: None.

Current Acquisition	Actual*	Selection Method	Actual*	Performer	Actual*
Cooperative Agreement	0%	Full & Open Competition	100%	Industry	30%
Cost Reimbursable	0%	Sole Source	0%	Government	0%
Fixed Price	30%		100%	NASA Intramural	70%
Grants	0%			University	0%
Other	70%	Sci Peer Review	0%	Non Profit	0%
* as of FY03 direct procurement	100%	* as of FY03 direct procurement		* as of FY03 direct procurement	100%

Future Acquisition - Major	Selection	Goals
Change to On-Site Contractors	Fall 03	100% Full & Open Competition

Agreements

Internal: None External: International Bilateral Cooperative Research Agreement (dated August 1999), as authorized by the early Station Utilization Memorandum of Understanding (MOU) between NASA and ESA. Changes since FY04 President's Budget: None.

Risk Mitigation

Risk Date: 1/15/2004

Top Risks	G	Overall	G	Cost	Y	Schedule	G	Technical	Probability	Impact	Mitigation Plan
Y	Physical Integration and end-to-end performance verification								moderate	low	Working with ESA

Independent Reviews

Review Types	Performer	Last Review Date	Next Review Date	Purpose
Independent Annual Review	MSFC/SMO	7/03	N/A	Independent Audit
ReMAP	Independent Committee	9/02	N/A	Set priorities for ISS Research

Theme: Physical Sciences Research
Development: Materials Science Research Rack – 1(MSRR-1)

BUDGET/LIFE CYCLE COST

Budget Authority ($ millions)	Prior	FY03	FY04	FY05	FY06	FY07	FY08	FY09	BTC	Total	Comments
FY2005 PRESBUD	85.0	8.8	15.0	7.5						116.3	--
Development	85.0	8.8	15.0	7.5						116.3	--
Changes since 2004 PRESBUD	+45.3	+3.8	-0.1	+6.0						+55.0	--
Development	+45.3	+3.8	-0.1	+6.0						+55.0	--
FY2004 PRESBUD	39.7	5.0	15.1	1.5						61.3	--
Development	39.7	5.0	15.1	1.5						61.3	--
Initial Baseline		5.0	15.1	1.5						21.6	--
Materials Science Research Rack1 (MSRR1)		5.0	15.1	1.5						21.6	--

Indicates changes since the previous year's President's Budget Submit
Indicates budget numbers in full cost.

Theme: Physical Sciences Research
Operations

PURPOSE

Objectives	Performance Measures
3.2, 3.3, 4.2, 9.2	5PSR1-9,11

PENDING EXPLORATION REPLANNING. The Physical Sciences Research (PSR) Program will combine unique experimental facilities with long-duration access to Low-Earth Orbit and beyond to enable new scientific discoveries and the development of technologies for the benefit of space exploration and Earth-based applications. (Note: PSR will be conducting a major review of priorities to ensure alignment of activities with the new Exploration vision. Some of the specific activities described here may change.)

OVERVIEW

The Physical Sciences Research Program will continue fabrication of ISS research racks and experiment inserts for the CIR, FIR, LTMPF, and MSRR-1. PSR plans to carry out manifested ISS research investigations in the first discipline focused racks (CIR) as well as in EXPRESS Racks and the Microgravity Science Glovebox in order to process the already selected flight investigations in the queue. The program will also initiate the newly validated and prioritized research program content and continue ground-based and flight research in the validated and prioritized research areas. PSR has a current roster of 62 flight investigations to be implemented between 2004 and 2008. PSR will also collaborate with the International Partners (ESA, DLR, CNES, JAXA) in order to plan the efficient utilization of all available ISS experiment facilities. Starting in FY 2004 OBPR will begin the Human Research Initiative. This will accelerate the acquisition of knowledge and technology needed for decisions on human exploration beyond low-Earth-orbit.

Please follow this link for additional data: http://spaceresearch.nasa.gov/

PROGRAM MANAGEMENT

The Enterprise Official for the Physical Sciences Research Theme is Mary Kicza, Associate Administrator for Biological & Physical Research. The HQ Division Director for Physical Sciences Research is Dr. Eugene Trinh. The PSR program responsibility is delegated to the Glenn Research Center, Jet Propulsion Laboratory, Johnson Space Center and Marshall Space Flight Center. Full compliance with NPR 7120.5B will be achieved in FY 04 for the relevant portions.

TECHNICAL COMMITMENT

PENDING EXPLORATION REPLANNING. Baseline commitment as of the FY 2004 PBS dated January 2003.

Technical Specifications	FY 2005 President's Budget	Change from Baseline
Multi-use Droplet Combustion Apparatus (MDCA)	Provide laboratory capability for combustion research	--
(Light Microscopy Module) LMM	Implement cross disciplinary research	--
(Quench Module Insert) QMI	Provides materials science research platform	--
Physics of Colliods in Space + (PCS+)	Implements fundamental research in complex systems	--
M1: Critical Dynamics in Microgravity (DYNAMX), Superconducting Microwave Oscillator Experiment (SUMO)	Implements fundamental physics external platform	--
Space Acceleration Measurement System	Implements environmental acceleration measurements	--
Protein Crystal Growth	Implements structural biology research in Express racks	--
Biospecimen Temperature Controller (BSTC)/Biotechnology Refrigerator (BTR)	Implements cell biotechnology research	--
Microgravity Science Glovebox	Provides a cross-disciplinary hands-on research platform	--
Primary Atomic Reference Clock in Space (PARCS)	Implements fundamental physics external platform	--

Schedule	FY 2005 President's Budget	Change from Baseline
Biospecimen Temperature Controller (BSTC)/Biotechnology Refrigerator (BTR)	Operations in US Lab	--
Microgravity Science Glovebox	Operations in US Lab	--
Protein Crystal Growth	Operations in US Lab	--
Space Acceleration Measurement System	Operations in US Lab	--
Multi-user Droplet Combustion Apparatus (MDCA)	FHA 10/2004	+3 Months
Light Microscopy Module (LMM)	FHA 12/2004	+4 Months

Theme: Physical Sciences Research
Operations

Schedule	FY 2005 President's Budget	Change from Baseline
Physics of Colliods in Space + (PCS+)	FHA in '05	+2 years
Quench Module Insert (QMI)	FHA 01/2006	+4 Months
Critical Dynamics in Microgravity (DYNAMX)	FHA 08/2007	--
Superconducting Microwave Oscillator Experiment (SUMO)	FHA 08/2007	--
Primary Atomic Reference Clock in Space (PARCS)	FHA 08/2007	--

ACQUISITION STRATEGY AND PERFORMING ORGANIZATIONS

The major prime contractors for PSR inserts or hardware are: Northrup-Grumman, Boeing and in-house civil service. Contracts typically cover 4 - 5 years of operation build time. Other activities include integration and operations, utilization and institutional requirements. Changes since the FY04 President's Budget: None.

Current Acquisition	Actual*	Selection Method	Actual*	Performer	Actual*
Cooperative Agreement	0%	Full & Open Competition	90%	Industry	60%
Cost Reimbursable	0%	Sole Source	10%	Government	0%
Fixed Price	5%			NASA Intramural	35%
Grants	0%		100%	University	5%
Other	95%	Sci Peer Review	%	Non Profit	0%
* as of FY03 direct procurement	100%	* as of FY03 direct procurement		* as of FY03 direct procurement	100%

Future Acquisition	Selection	Goals
Change to Cost Plus	Fall 03	100% Full & Open Competition, 5% SB, 100% Cost Plus

AGREEMENTS

Internal: None. External: None. Changes since the FY04 President's Budget: None.

RISK MITIGATION

Risk Date: 1/15/2004

Top Risks	G	Overall	G	Cost	G	Schedule	G	Technical	Probability	Impact	Mitigation Plan
G	Availability of flight opportunities determines ability to execute mission								low	low	N/A

INDEPENDENT REVIEWS

Review Types	Performer	Last Review Date	Next Review Date	Purpose
ReMAP	Independent Committee	9/02	N/A	Set priorities for ISS research
National Academy	NRC/SSB	6/02	N/A	Independent science assessment

BUDGET

Budget Authority ($ millions)	FY 2003	FY 2004	FY 2005	Comments
FY2005 PRESBUD	102.3	158.4	107.0	
ISSRC Physical Sciences Research (Operations)	102.3	158.4	107.0	
Changes since 2004 PRESBUD	+19.2	-1.4		
ISSRC Physical Sciences Research (Operations)	+19.2	-1.4		
FY2004 PRESBUD	83.1	159.8		
ISSRC Physical Sciences Research (Operations)	83.1	159.8		

Indicates changes since the previous year's President's Budget Submit

Indicates budget numbers in full cost.

Theme: Physical Sciences Research
Research

PURPOSE

Objectives	Performance Measures
3.2, 3.3, 4.2, 9.2	5PSR1-9,12

PENDING EXPLORATION REPLANNING. The strategic objective of the Physical Sciences Research is twofold: Strategic Research and Fundamental Research. The Strategic Research area emphasizes the basic and applied research that the Agency relies uniquely upon OBPR to conduct to enable NASA's mission to explore the Universe and search for life. The Fundamental Research area emphasizes the basic and applied research to address the role of gravity in biological and physical processes of inherent scientific interest and of potential technological applications on Earth. (Note: PSR will be conducting a major review of priorities to ensure alignment of activities with the new Exploration vision. Some of the specific activities described here may change.)

OVERVIEW

The Physical Sciences Research (PSR) Program sponsors peer-reviewed, interdisciplinary ground-based and flight research focusing on most recent and exciting areas of atomic and biomolecular physics and chemistry, groundbreaking research in biotechnology, and significant new developments in materials science, fluid physics, and combustion research. A unique component of the program is the cross-disciplinary research in the microgravity environment of space to increase understanding of those physical and chemical phenomena affecting biological systems that are masked by the effects of gravity on Earth. The PSR research program is divided into two areas: strategic research and fundamental microgravity research. The key difference between the two areas is the strategic research focus on developing advanced technology for both robotic and human deep space flight. Fundamental microgravity research focuses on tackling both challenging basic scientific issues as well as addressing technical challenges relevant to Earth-based applications. The program is reviewed by the external research community through the National Research Council (National Academy of Sciences), NASA-convened external Advisory Committees, and NASA-convened ad-hoc Review Committees. Standing Discipline Working Groups review the progress of the detailed research activities. Starting in FY 2004 OBPR will begin the Human Research Initiative. This will accelerate the acquisition of knowledge and technology needed for decisions on human exploration beyond low-Earth orbit.

Please follow this link for additional data: http://spaceresearch.nasa.gov/

PROGRAM MANAGEMENT

The Enterprise Official for the Physical Sciences Research Theme is Mary Kicza, Associate Administrator for Biological & Physical Research. The HQ Division Director for Physical Sciences Research is Dr. Eugene Trinh. The PSR research program has program responsibility delegated to the Glenn Research Center, Ames Research Center, Jet Propulsion Laboratory, Johnson Space Center and Marshall Space Flight Center. Full compliance with NPR 7120.5B will be achieved in FY 04 for the relevant portions.

TECHNICAL COMMITMENT

PENDING EXPLORATION REPLANNING. Baseline commitment as of the FY 2004 PBS dated January 2003.

Technical Specifications	FY 2005 President's Budget	Change from Baseline
R & T NRA commitments	Conduct productive and innovative ground and flight peer-reviewed research using a broad scientific and technological community.	--
R & T NASA Center Support	Provide research and development support to the PSR investigator communities.	--
R & T Science Disciplines	The relevant science disciplines are: Biotechnology, Bio-engineering, Combustion, Fluid Physics, Fundamental Physics, Materials Science.	--

Schedule	FY 2005 President's Budget	Change from Baseline
Research Announcements Release	03 NRA - 2/04, 04 NRA - 2/05	--
Research Awards	Award 3/04, Award 3/05	--

Theme: Physical Sciences Research
Research

Acquisition Strategy and Performing Organizations

The initial NASA Research Announcements (NRA) was first issued in 1988. Research is selected by competitive sourcing through these annual NRAs by disciplines in area research emphasis. Grants typically are for 2 - 4 year increments. In FY03, direct NRA Grant procurement represented 75% of budget authority. Changes since the FY04 President's Budget: None.

Current Acquisition	Actual*	Selection Method	Actual*	Performer	Actual*
Cooperative Agreement	0%	Full & Open Competition	100%	Industry	25%
Cost Reimbursible	0%	Sole Source	0%	Government	0%
Fixed Price	0%			NASA Intramural	15%
Grants	75%		100%	University	60%
Other	25%	Sci Peer Review	100%	Non Profit	0%
* as of FY03 direct procurement	100%	* as of FY03 direct procurement		* as of FY03 direct procurement	100%

Future Acquisition - Major	Selection	Goals
Annual research announcements	Winter 03	100% Sci Peer Review, 100% Grants

Agreements

Internal: None. External: MOUs with NIH and DOE for ground-based and flight research. Changes since FY04 President's Budget: None.

Risk Mitigation

Risk Date: 1/15/2004

Top Risks	G	Overall	G	Cost	G	Schedule	G	Technical	Probability	Impact	Mitigation Plan
G	Availability of flight opportunities determines ability to execute mission.								low	low	N/A

Independent Reviews

Review Types	Performer	Last Review Date	Next Review Date	Purpose
National Research Council Committee	NAS/NRC	6/02	N/A--	NAS research progress & quality evaluation
External Advisory Committees	BPRAC	8/03	2/04	Advisory Committees Research progress reviews
ReMap	Independent Committee	9/02	N/A	Set priorities for ISS research

Budget

Budget Authority ($ millions)	FY 2003	FY 2004	FY 2005	Comments
FY2005 PRESBUD	**90.1**	**151.3**	**159.4**	--
Physical Science Research (Strategic/Fundamental)	90.1	151.3	159.4	--
Changes since 2004 PRESBUD	-44.0	+13.6		--
Physical Science Research (Strategic/Fundamental)	-44.0	+13.6		Changes due to institutional adjustments.
FY2004 PRESBUD	134.1	137.7		--
Physical Science Research (Strategic/Fundamental)	134.1	137.7		--

Indicates changes since the previous year's President's Budget Submit
Indicates budget numbers in full cost.