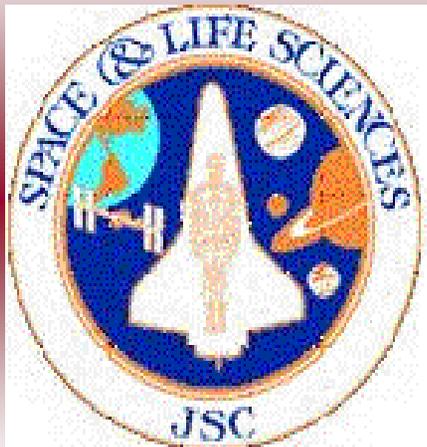


National Aeronautics & Space Administration
Johnson Space Center



Space and Life Sciences Directorate Overview

Presented by
John A. Rummel, Ph.D.
Deputy Director, Space and Life Sciences

Presentation Overview

- ✓ **SLSD and JSC**
- ✓ **SLSD Mission**
- ✓ **Organization**
- ✓ **Responsibilities**
- ✓ **The Divisions**
 - **Medical Sciences**
 - **Flight Projects Division**
 - **Program Integration**
 - **Earth Science & Solar System Exploration**
- ✓ **The Challenge**
- ✓ **The Response**



7/23/99: Liftoff of Space Shuttle Columbia on mission STS-93.

The Big Picture



The mission of the Johnson Space Center is
the expansion of a human presence in space
through exploration and utilization for the
benefit of all:

- **Lead center for the Human Exploration and Development of Space Enterprise in**
 - ✓ Space Medicine
 - ✓ Space Biomedical Research and Countermeasures
 - ✓ Advanced Human Support Technology
- **Lead in Astromaterials**
 - ✓ Galactic and solar wind
 - ✓ Interplanetary dust
 - ✓ Materials from comets, asteroids and other planetary bodies

SLSD Mission



The mission of the Space and Life Sciences Directorate is to be the world's leader in understanding the space frontier and the opportunities, capabilities, and limitations of humans living and working on that frontier.



SLSD Role



The Directorate plays an enabling role:

- ✓ Expanding human activities beyond low Earth orbit
- ✓ Supporting missions in Earth orbit
- ✓ Contributing to fundamental knowledge about human capabilities
- ✓ Contributing to fundamental knowledge about the solar system around us

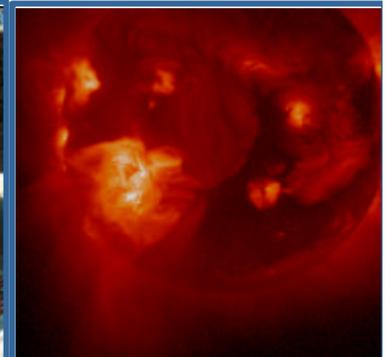
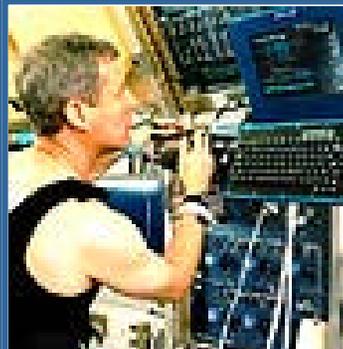
highly skilled personnel

unique facilities

space flight experiments

new technologies

S
L
S
D



SLSD Personnel



Update

| | <u>Civil Servants</u> | <u>Contractors</u> |
|-----------------------|-----------------------|--------------------|
| SA | 15 | 0 |
| Division | 55 | 431 |
| tion Office | 12 | 33 |
| ce & Solar System | 132 | Exploration |
| ght Projects Division | 63 | 312 |
| Total | 188 | 908 |

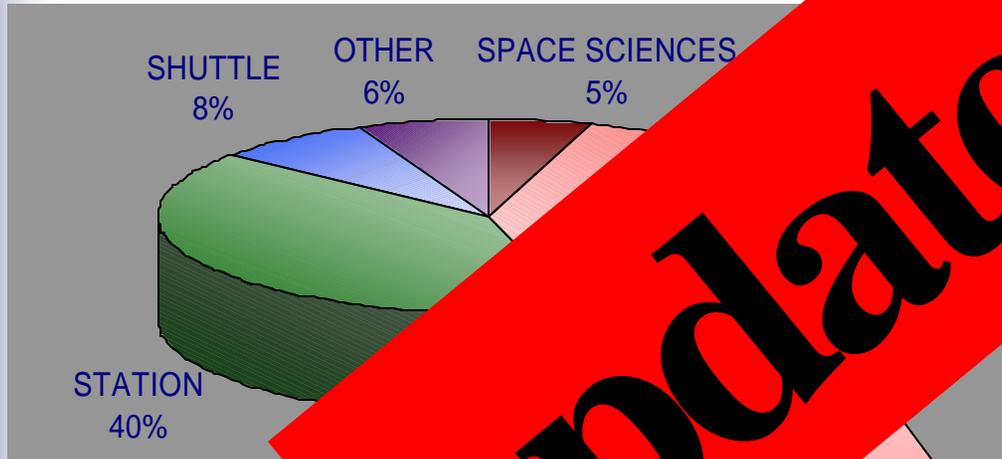


as of 6/99

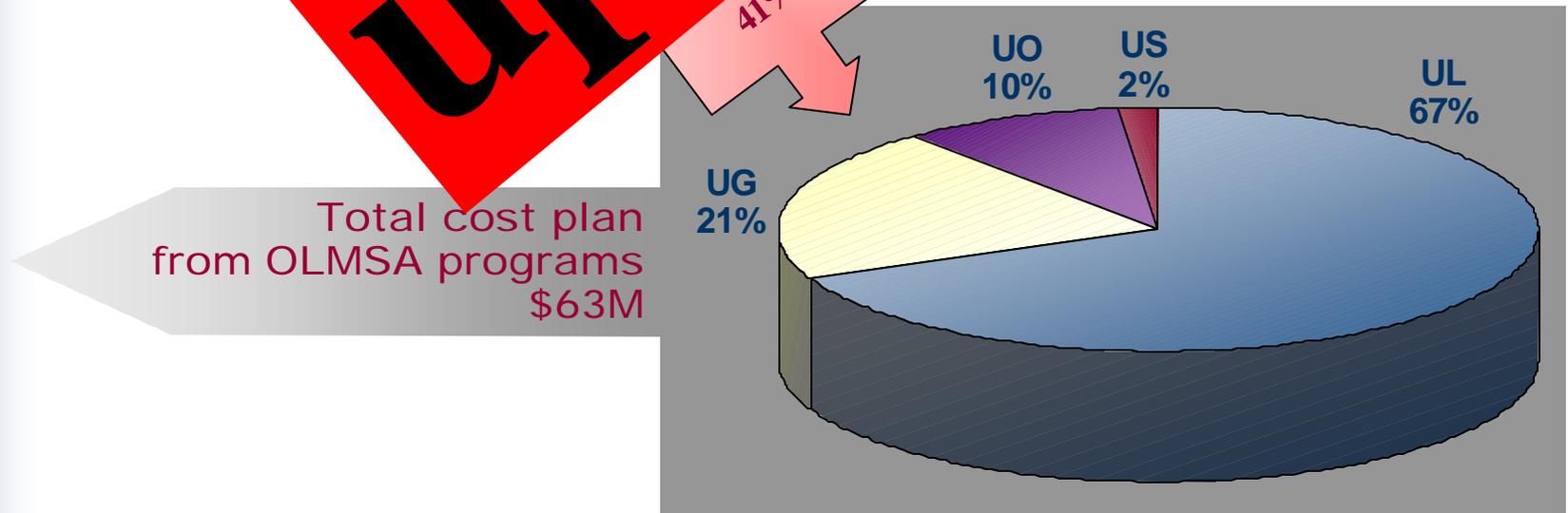
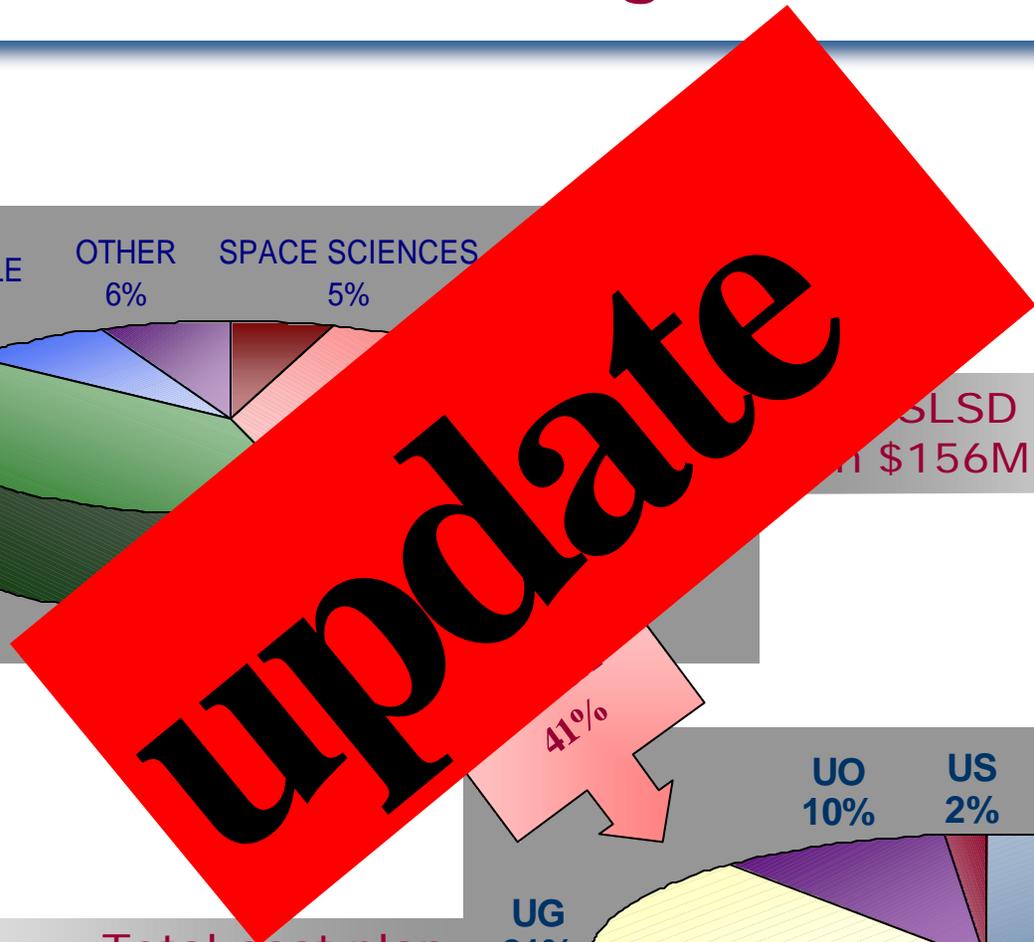
SLSD Budgets



SLSD



SLSD cost
\$156M in FY 99



Total cost plan
from OLMSA programs
\$63M

The Organization



OFFICE OF THE DIRECTOR/SA
 Director: Dave R. Williams, M.D., FRCP
 Deputy Director: John A. Rummel, Ph.D.
 Associate Director: Richard W. Nygren

Program Integration - SL

Human Resources

JSC Astrobiology Institute - SA4

Public Affairs

Medical Sciences Division - SD

Earth Science Exploration

Projects Division SF

Biotechnology Cell Science Office - SD12

Medical Operations Branch - SD2

Life Sciences Research Laboratories - SD3

Planetary Science Branch - SN2

Planetary Science Branch - SN2

Space Science Branch - SN3

Program Support Office - SF2

Planning & Integration Branch - SF3

Flight Research Management Branch - SF4

Space Human Factors Branch - SP5

Crew Station Branch - SF6



S
L
S
D

Human Space Life Sciences Programs Office

HLSPO integrates efforts in the *Human Exploration and Development of Space Enterprise (HEDS)* for program elements of

- Advanced Human Support Technology
- Biomedical Research & Countermeasures
- Space Medicine

Missions:

- Bridge Headquarters strategy (what/why) and JSC implementation (how)
- Develop critical path roadmap
- Coordinate resources to yield integrated program
- Build a framework to meet agency & HEDS needs



JSC Astrobiology Institute

Guiding Questions of the NASA Astrobiology Institute

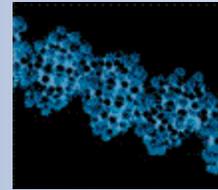
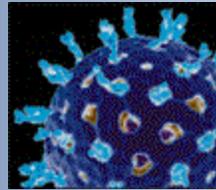
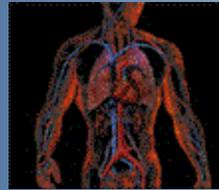
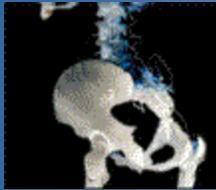
- *How Does Life Begin and Develop?*
- *Does Life Exist Elsewhere in the Universe?*
- *What is Life's Future on Earth and Beyond?*

Mission of lead member, JSC Astrobiology Institute:

- ✓ identify and develop innovative new biomarkers
 - biominerals
 - elemental and isotopic fractionation
 - morphologic features on the micrometer and nanometer scale
 - specific organic molecules
- ✓ investigate how nonbiologic processes may produce biomarker imposters



National Space Biomedical Research Institute



S
L
S
D

Mission: Combine the basic research capabilities of the nation's leading biomedical research laboratories with the operational & applied research of NASA to understand & remove the impediments to safe & effective human exploration & development of space

- ✓ design, implement & validate effective countermeasures
- ✓ define molecular, cellular, and organ-level responses to foster development of countermeasures
- ✓ establish biomedical support technologies
- ✓ transfer and disseminate biomedical advances in knowledge & technology
- ✓ ensure open involvement by the scientific community, industry, and the public

*Baylor College of Medicine
Harvard Medical School
Johns Hopkins University
Massachusetts Institute of Technology
Morehouse School of Medicine
Rice University
Texas A&M University*

Program Integration Office Organization

SLSD

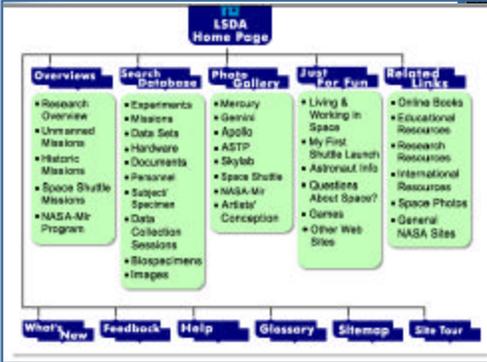
PROGRAM INTEGRATION OFFICE
 Manager: Judith L. Robinson, Ph.D.
 Assistant Manager: Earl W. Tiedt

Resources Management

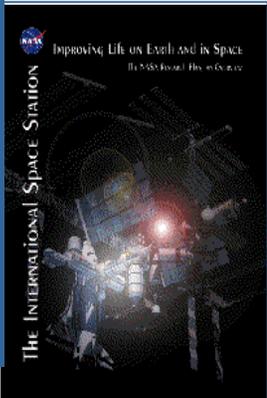
Planning and Integration

Information Management

Outreach



Schoolchildren explore mission support hardware with Outreach activities.

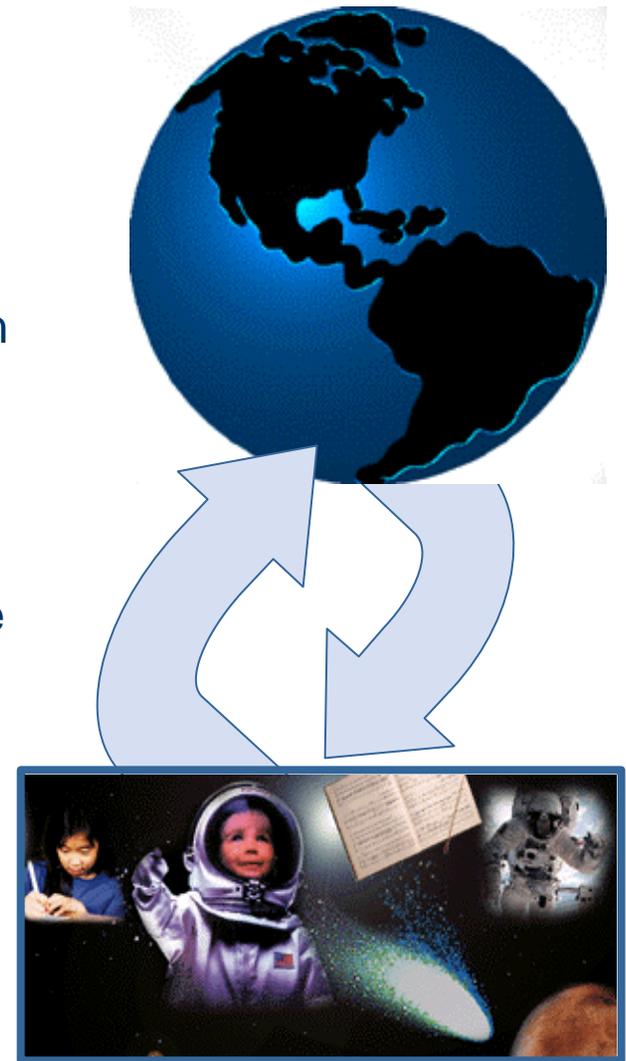


Program Integration Office

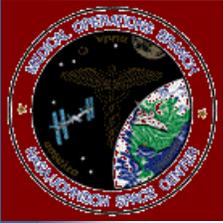
Mission

S
L
S
D

- Provide management oversight, coordination, and integration
- Plan and integrate programs and projects that increase the knowledge base required for human adaptation to space
- Enable the efficient execution of SLSD program management
- Disseminate information to the public and involve the larger community in the adventure of exploring space
- Oversee the identification of technologies to maintain human health and performance in space, and identify opportunities for space commerce and terrestrial applications of exploration technology



Medical Sciences Division Organization



S
L
S
D

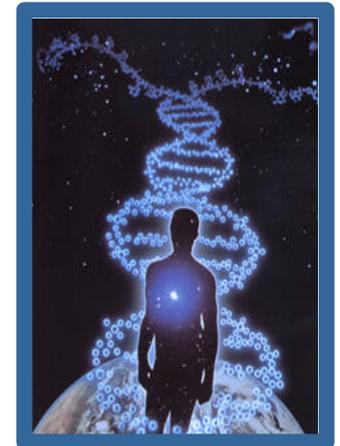
MEDICAL SCIENCES DIVISION - SD

Chief: David L. Dawson M.D.
Deputy Chief: Jerry L. Homick, Ph.D.

Biotechnology Cell
Science Office - SD12
Manager: Neal Pellis, Ph.D.

Medical Operations Branch
SD2
Chief: Roger D. Billica, M.D.

Life Sciences Research
Laboratories - SD3
Chief: William Paloski, Ph.D.



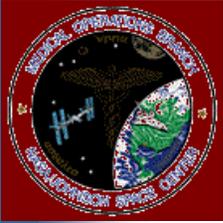
Medical Sciences Division Mission



S
L
S
D

- Conduct a broad array of peer-reviewed ground-based and flight medical operations and biomedical research
- Optimize the health, safety, and performance of flight crews during all phases of space flight
- Implement innovative biotechnology research and development programs
- Provide institutional support in the areas of occupational medicine and environmental health

Medical Sciences Division Responsibilities



S
L
S
D

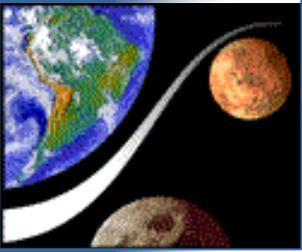
Biomedical Research & Countermeasures Program

- ⇒ Human ground-based research
- ⇒ Countermeasures development & validation
- ⇒ Radiation
- ⇒ Human flight research
- ⇒ National Space Biomedical Research Institute collaboration

- ⇒ Occupational medicine
- ⇒ Environmental health
- ⇒ Human support systems
- ⇒ Science payloads management support
- ⇒ Biotechnology cell science
- ⇒ Advanced human support technologies

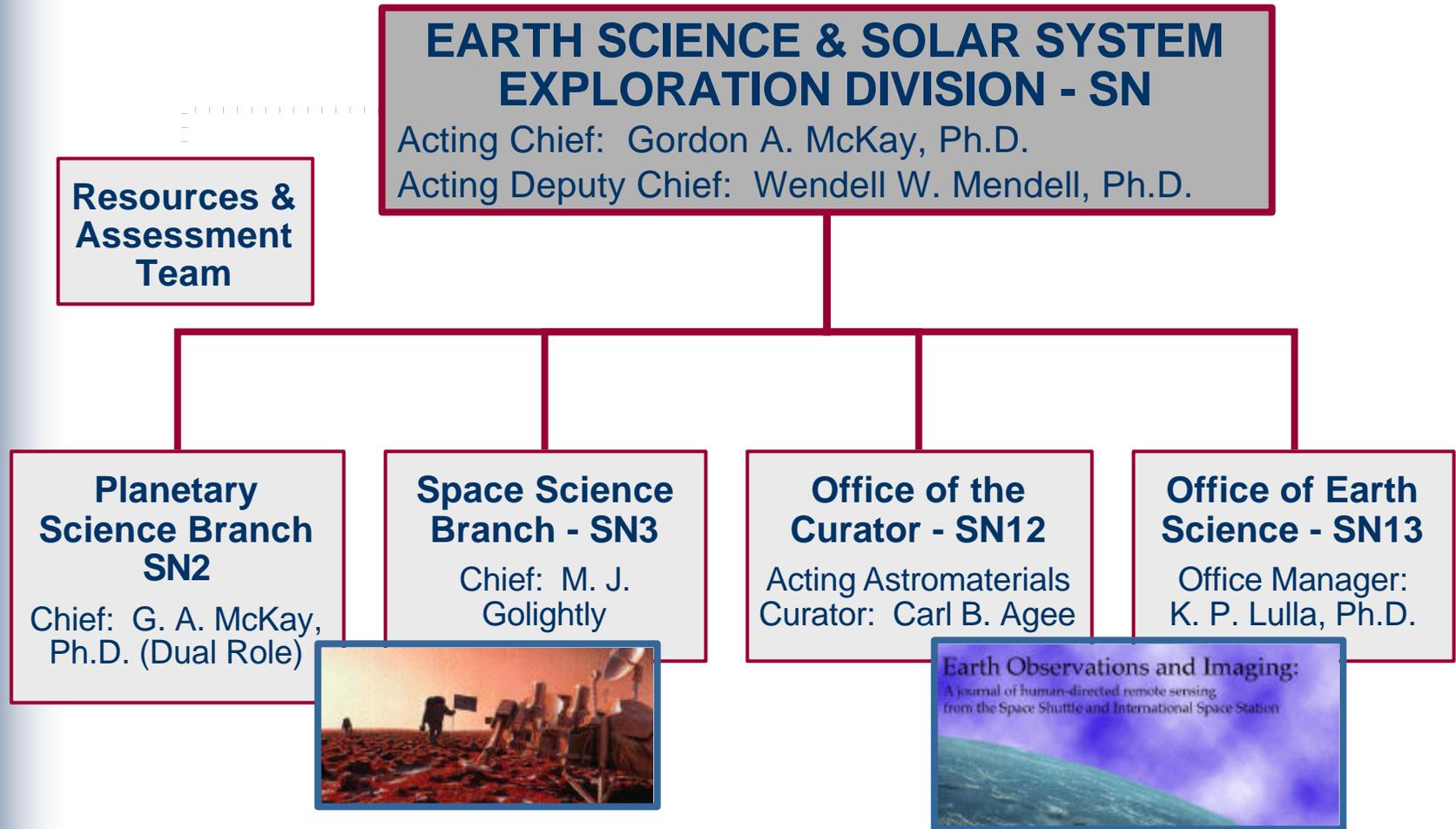
Space Medicine

- ⇒ Astronaut health
- ⇒ Mission support
- ⇒ Training
- ⇒ Environmental health
- ⇒ Psychological support
- ⇒ Epidemiology
- ⇒ Space medicine monitoring & countermeasures
- ⇒ Clinical care capability development

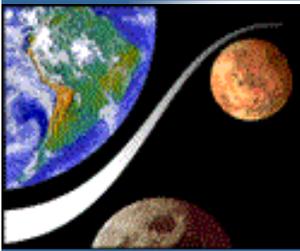


Earth Science & Solar System Exploration Division Organization

S
L
S
D

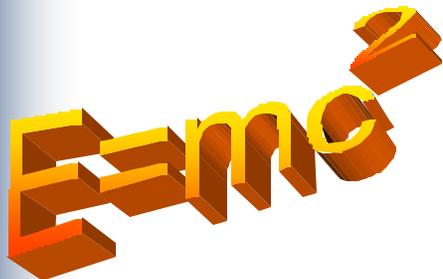
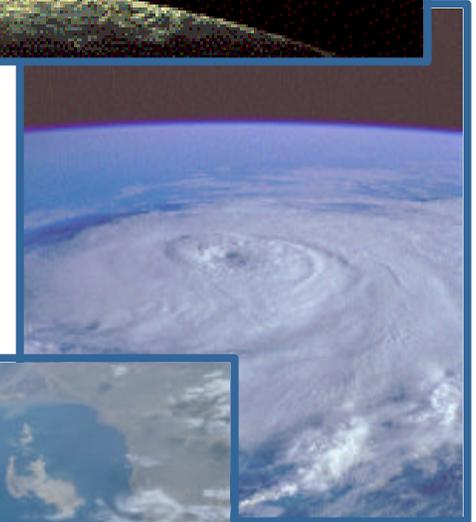


Earth Science & Solar System Exploration Division Mission

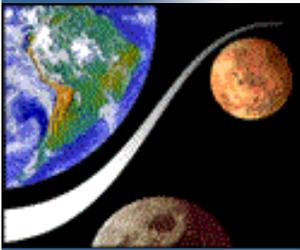


S
L
S
D

- Conduct frontier, world-class scientific research in Earth, space, and planetary science
- Give authoritative science and technology support to NASA and international programs
- Participate directly in NASA missions
- Communicate through education and outreach NASA science to professional peers, educators, and the public

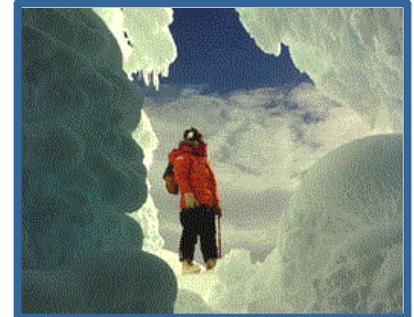


Earth Science & Solar System Exploration Division Responsibilities



S
L
S
D

- ✓ Astronaut Earth observations
- ✓ Planetary materials collection, curation, and research
- ✓ Orbital debris
- ✓ Radiation dosimetry
- ✓ Planning and strategy for solar system exploration

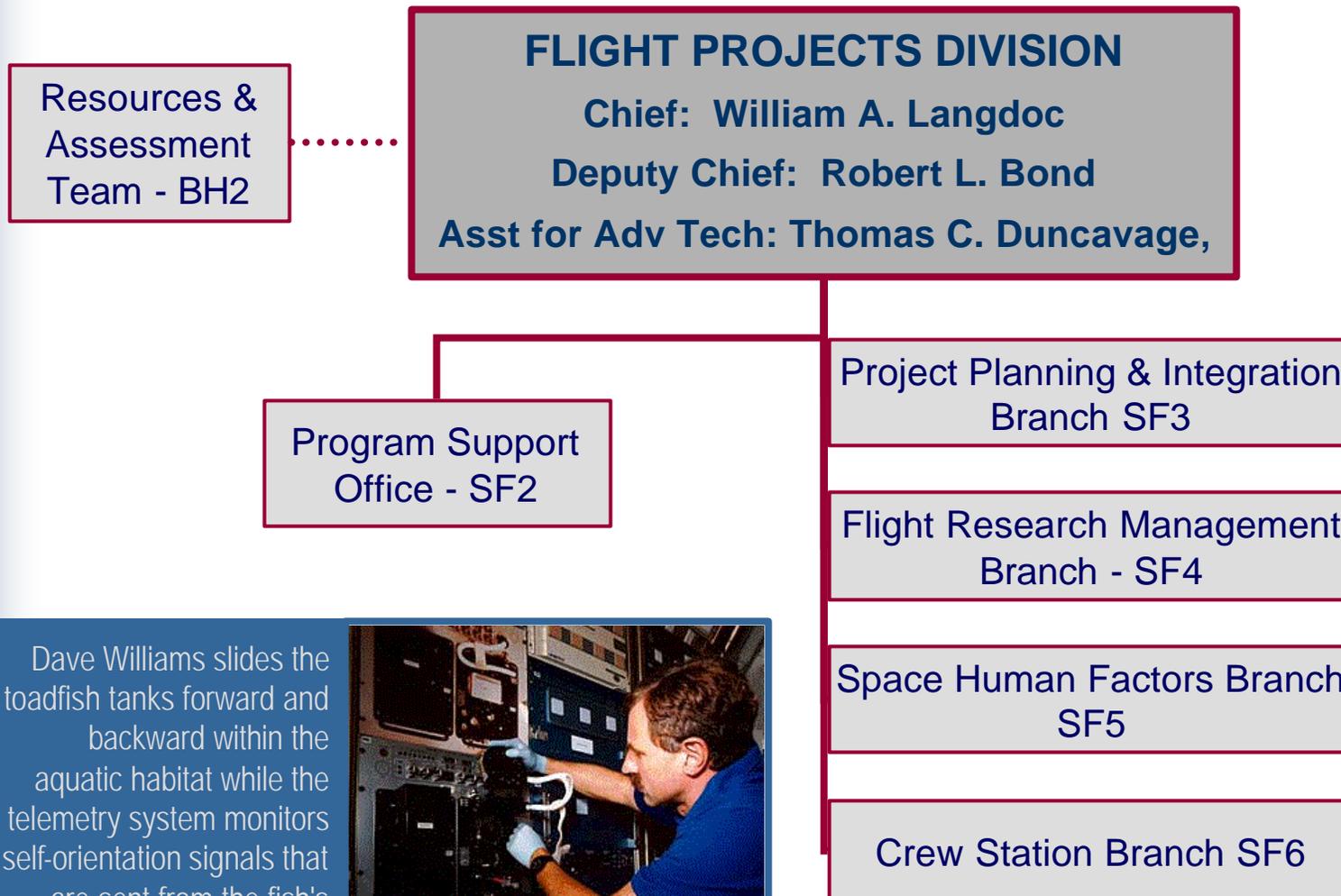


U.S. meteorite collection team member stands at the opening of an ice cave in Antarctica.



STARDUST spacecraft preparing to collect dust from the coma of Comet Wild-2 in 2004

Flight Project Division Organization

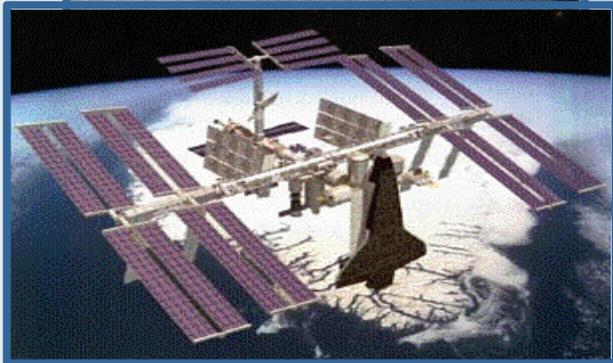


Dave Williams slides the toadfish tanks forward and backward within the aquatic habitat while the telemetry system monitors self-orientation signals that are sent from the fish's gravity sensors to its brain.



Flight Project Division Mission

S
L
S
D



Provide the centralized flight project control and management within the SLSD:

- experiment payload integration
- mission management
- operations
- space human factors research

Flight Project Division Responsibilities

S
L
S
D

- Shuttle mission and ISS increment management
- Flight & mission operations
- HLS experiment management
- Program interface
- Analytical and physical integration
- Hardware acceptance testing
- SPACEHAB utilization
- Science operations (telescience) support
- Ground-based research management

Crew Station

- Crew station integration
- Stowage and CCCD/SSCCD
- Architectural concept development
- Acoustical assessment
- Program applied human engineering



Body Mass Measurement Device
(BMMD)

Space Human Factors

- Space human factors research, analysis, and lab operation
- Food system development and lab operation
- Advanced habitability technology
- Manned system integration standards (MSIS)

Space & Life Sciences Facilities

S
L
S
D

- ✓ **National Space Biomedical Research Institute (NSBRI) Office**
 - ✓
- ✓ **SA4 - JSC Astrobiology Institute**
 - ✓
- ✓ **SD - Medical Sciences Division**
 - ✓ **SD12 - Biotechnology Cell Science Office**
 - SD13 - Occupational Health & Test Support Office**
 - SD2 - Medical Operations Branch**
 - SD3 - Life Sciences Research Laboratories**
- ✓
- ✓ **SI - Program Integration Office**

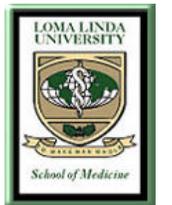
NSBRI Facilities

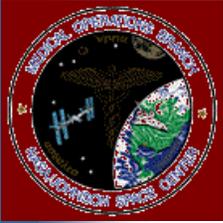
S
L
S
D

- ✓ Man Vehicle Lab at MIT
- ✓ Human Performance Lab at York.
- ✓ JHU/SOM Center for Hearing & Balance (Shelhamer)
- ✓ JHU/SOM Ocular Motor Physiology Lab (Zee)
- ✓ JHU/SOM Neurophysiology Lab (Minor)
- ✓ Massachusetts General Hospital Biomotion Laboratory (Krebs)
- ✓ Dartmouth College (Taube)
- ✓ Baylor College of Medicine Center for Balance Disorders
- ✓ Neuroscience Laboratory - NASA JSC (Bloomberg, Paloski)
- ✓ Applied Physics Laboratory

JOHNS HOPKINS
UNIVERSITY

Johns Hopkins Medicine





Medical Sciences Division Technical Facilities

S
L
S
D



Exercise Physiology Lab

Laboratories

- Biochemistry
- Bone and muscle
- Cardiovascular
- Endocrinology
- Environmental health
- Environmental physiology
- Exercise physiology
- Neuroscience
- Psychology and behavior
- Water and food analysis
- Nutritional biochemistry

Facilities

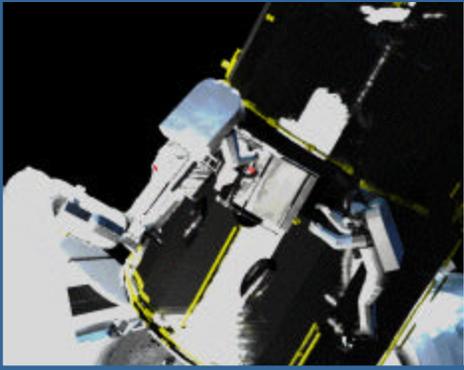
- Hypobaric and hyperbaric chambers
- Manned test support
- Medical experiments data collection
- Preflight adaptation trainer



Head Trunk Stabilization Test
System

Flight Project Division Facilities

GRAF analysis of an EVA task scheduled for the first HST servicing mission (generated preflight).



➤ **Food Development Laboratory**

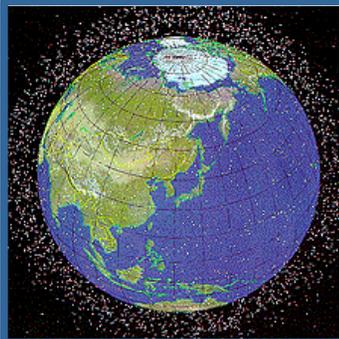
➤ **Human Factors Laboratories**



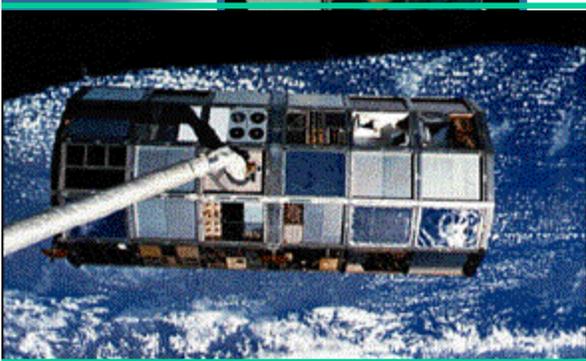
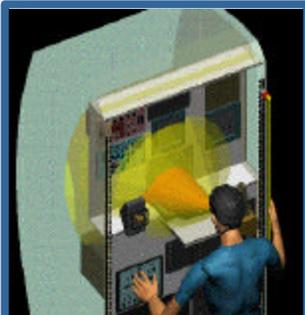
Downlinked video of the actual EVA task during the first HST servicing mission

SLSD Responsibilities

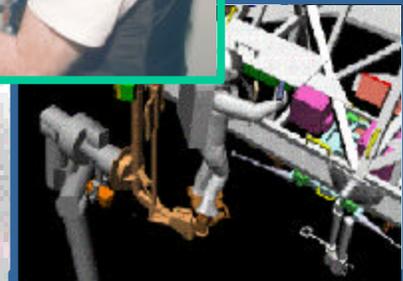
S
L
S
D



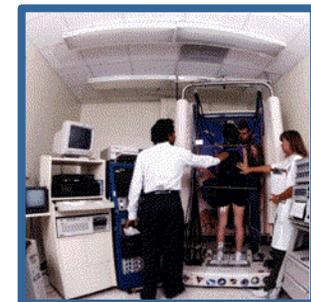
Orbital debris



- ✓ Biomedical research countermeasures
- ✓ Space medicine
- ✓ Occupational medicine environmental health
- ✓ Human support systems
- ✓ Science payloads management
- ✓ Biotechnology cell science
- ✓ Space science
- ✓ Advanced human support technologies
- ✓ Program management and integration
- ✓ Safety and VPP



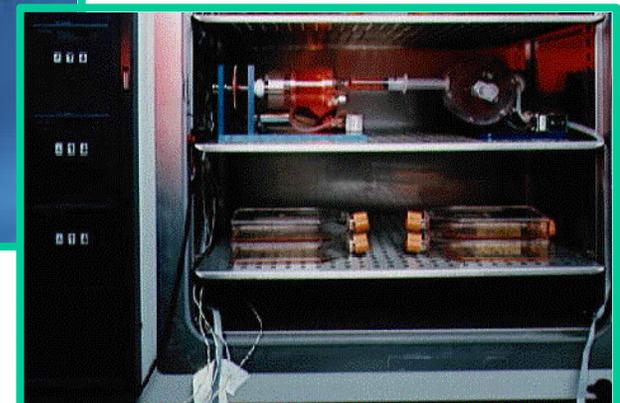
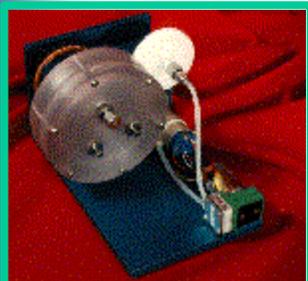
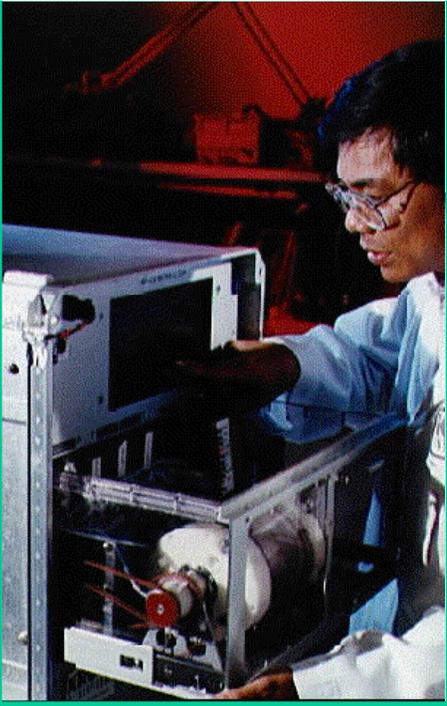
Evaluation of ISS truss structure using HVES



Computerized dynamic posturography test system

SLSD Bioreactor

JSC scientists and engineers designed and developed the rotating well vessel bioreactor



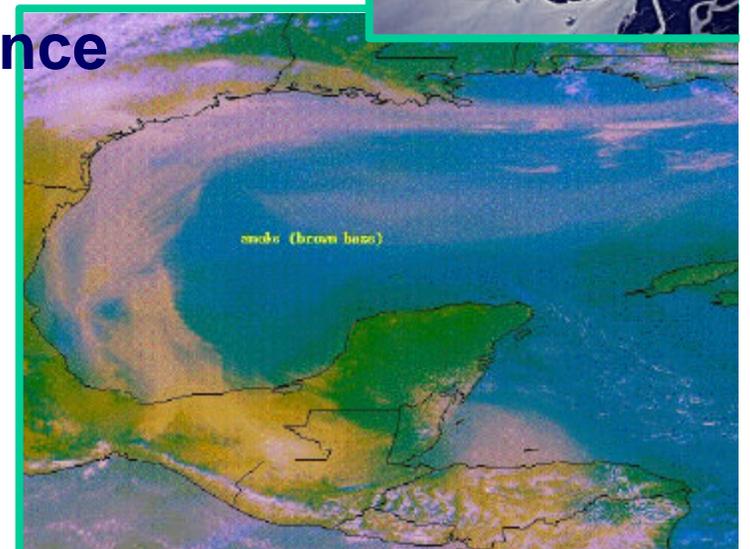
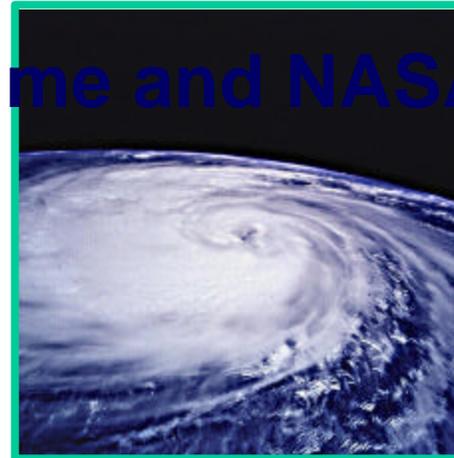
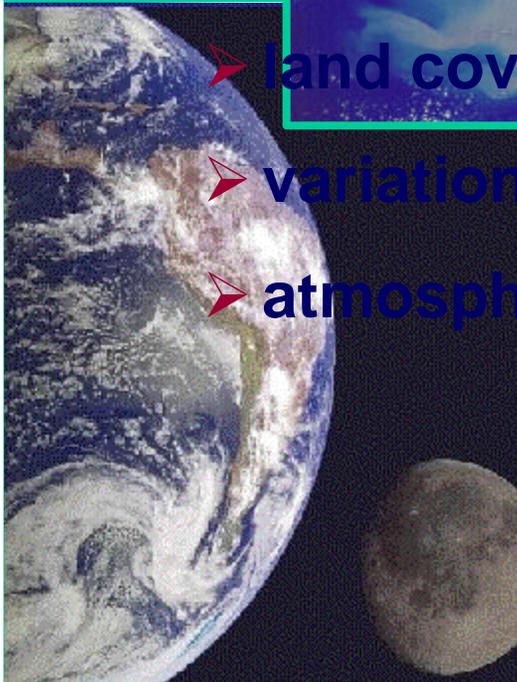
Earth Science

The Earth changes over time and NASA can track these changes

- predict natural disasters
- land cover and land use
- variations in total solar irradiance
- atmospheric constituents



S
L

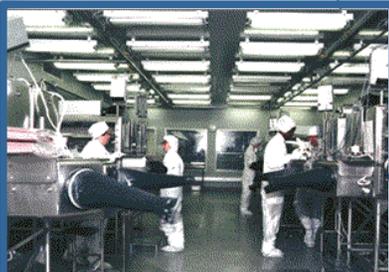




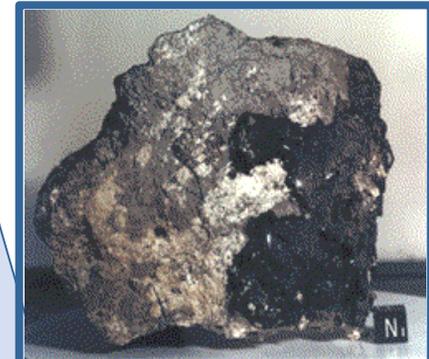
Earth Science & Solar System Exploration Division Facilities

S
L
S
D

- ✓ Planetary and Earth Sciences Laboratory
- ✓ Space Materials Research Laboratory
- ✓ Orbital Debris Tracking Facility and Test Pad



Stainless steel glove box cabinets line either side of the Pristine Sample Laboratory.



A one-kilogram (2.2lb) Apollo 16 breccia rock formed from meteorite impact. Shiny, black, glass was on the other side.



*Particle
handling*



*Virtual Research
Head-mounted
Display*

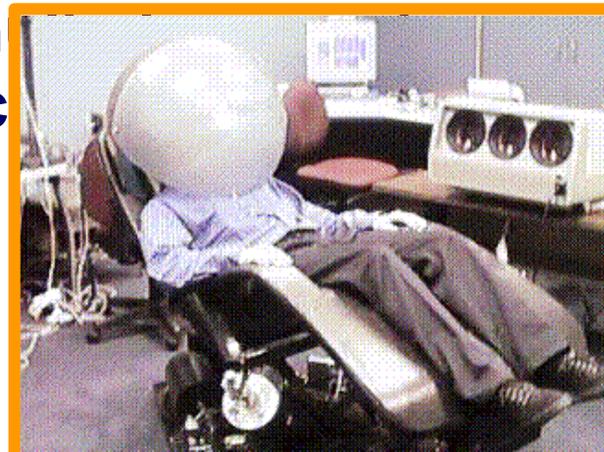
Virtual Reality Training Lab

- Developed in conjunction with the University of Houston
- Immersive, spatially expansive training environment
- Interactive
- Displays visual components of virtual environments on monitors, stereoscopic head-mounted displays, and projection displays

**Allows m
analyze c**

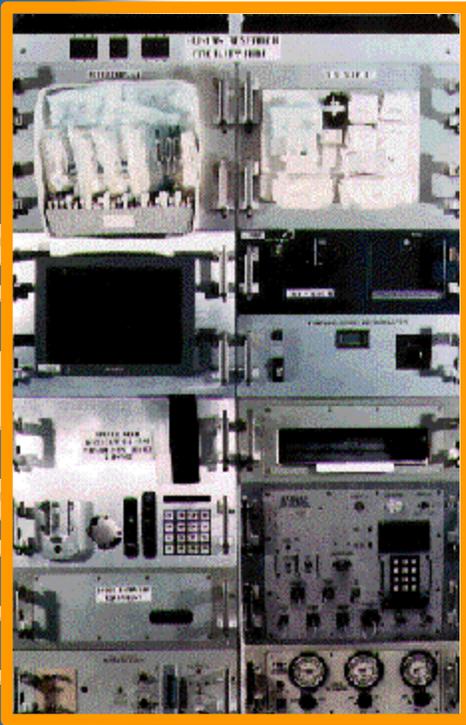


CyberGrasp haptic feedback users "touch" computer-generated objects & experience realistic force feedback via the human hand

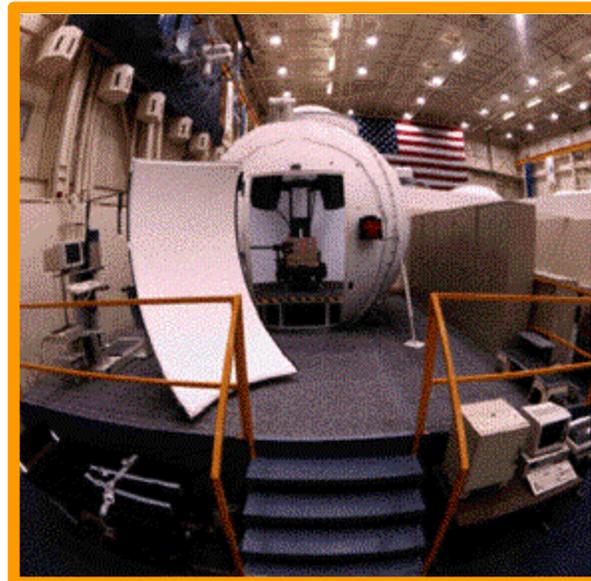


Personal motion platform provides 2-6 degrees-of-freedom, with chairs conforming to the modified neutral buoyancy posture of the human body

Life Sciences Training Facilities



This is a high fidelity trainer and replica of the Human Research Facility that will be used aboard the ISS to monitor and test body functions of crew members

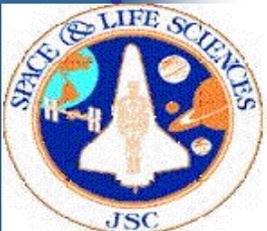


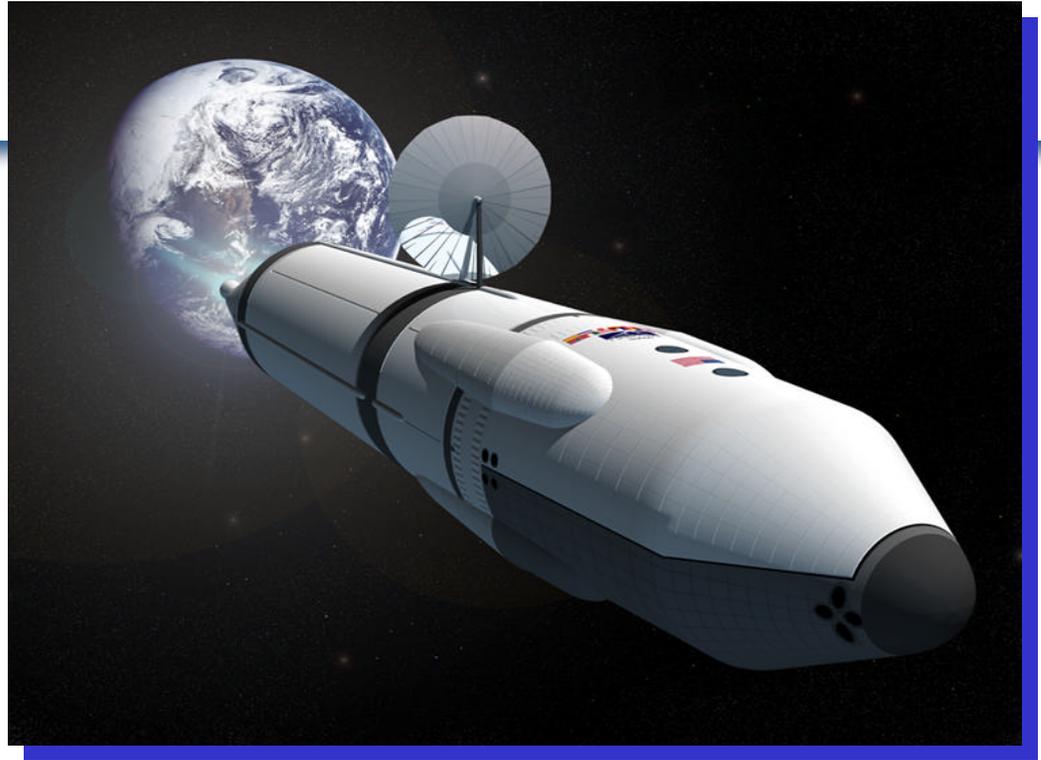
Preflight Adaptation Trainer System



Glovebox, uses for this trainer include training crewmembers to handle potentially contaminated materials or materials that should be protected from the surrounding environment

- **A new thrust - Bioastronautics - has been formulated**
- **Led to a budget augmentation request from NASA**
- ✓ **Expanded extramural community participation through the National Space Biomedical Research Institute (NSBRI) is an important component of this overall concept**





- ✓ ***An Integrated Approach to Ensure Healthy and Safe Human Space Travel-***
- ✓ ***While Assisting in the Solution of Earth-based***

during previous
ground and
flight

biomedical
research

- It is now appropriate to apply this knowledge base to applications and solutions which will provide safer human operations in

Why Now?

of fulfilling
NASA's original

vision for
science
institutes

- Significant leverage into scientific community to focus on NASA issues while transferring knowledge to Earth based problems
- Cooperation

Bioastronautics

✓ Approach

➤ Increase safety and health by reducing risk

S ✓ Augmentation elements

L ➤ Habitation/environmental health

S ➤ Adaptation/countermeasures
(National Space Biomedical Research Institute)

D

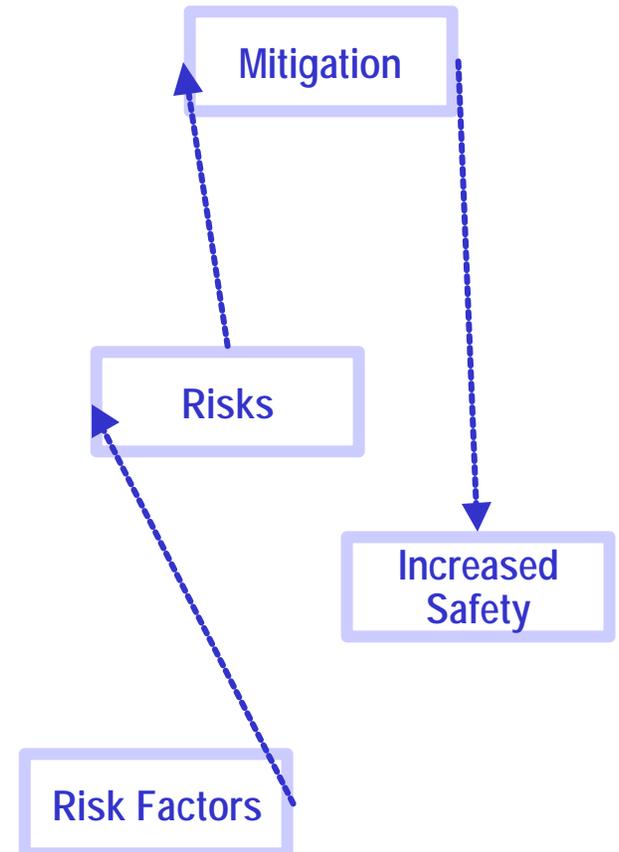
➤ Health care system research

Critical Path Roadmap Project

➤ Cross-cutting functions

➤ Missions

➤ Education & outreach



What's New

✓ Major Changes

- Systematic identification of risks and risk mitigation deliverables
- Realignment of responsibilities, organizational structure, and processes
- Major participation between NASA and the external community through the partnership with the National Space Biomedical Research Institute (NSBRI)
- Increase in resources
- Planned initiation of a Wood's Hole model to energize and catalyze

S
L
S
D



Outcome

✓ **Enhanced ability to deliver crew health care**

S ✓ **Ability to understand and handle the human biomedical risks that accompany space flight**

L

S

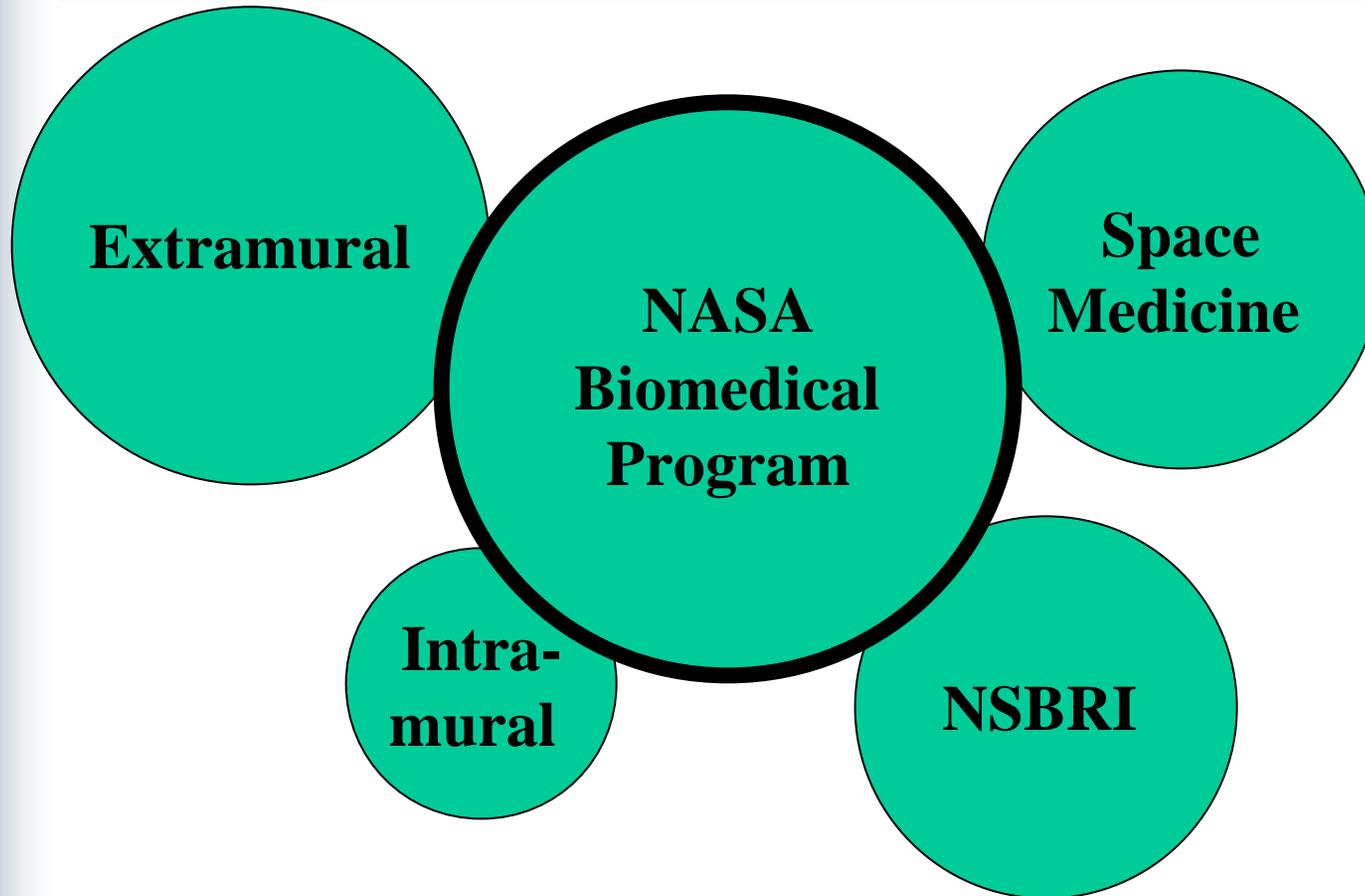
D

➤ **Significant participation by the external scientific community**

➤ **Requirements to guide programmatic prioritizations and decisions (cost/benefit analyses)**

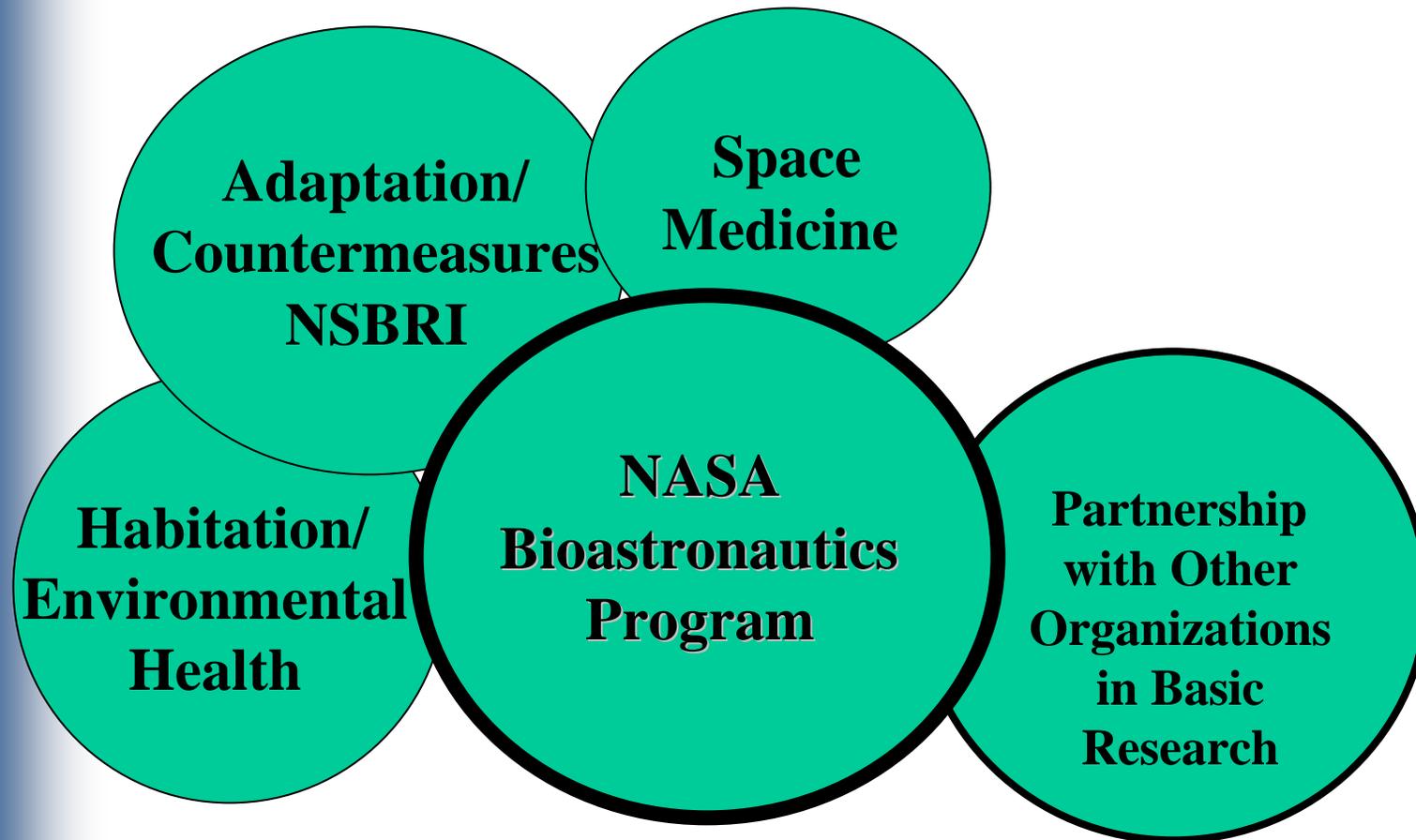
➤ **Improved metric tracking of progress and deliverables**

Where We Have Been



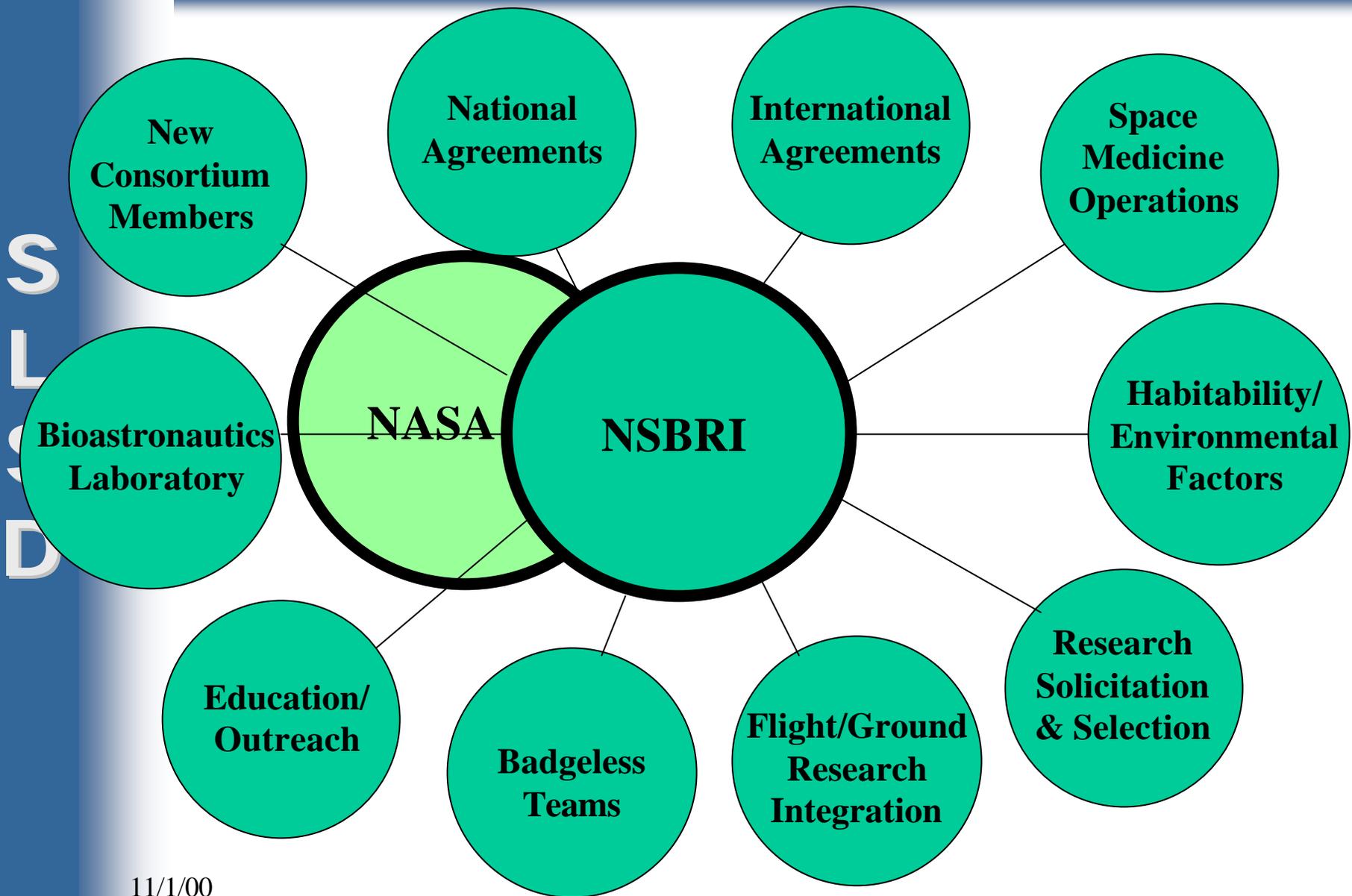
Focus on Understanding

What We Are Implementing



Focus on Solutions
through Understanding

Full Community Participation



Implementation Thrusts



HQ/JSC Bioastronautics Structure [Proposed]

NASA
Administrator

Bioastronautics Program
Commitment Agreement

HQ Code U
Associate
Administrator

HQ Code M
Associate
Administrator

JSC - Center
Director

Bioastronautics
Program Office

Implementing
Centers - ARC, JSC,
MSFC, LRC, GRC

S

L

S

D

Deputy
Administrator
Bioastronautics
position
to

Identifying Responsibilities

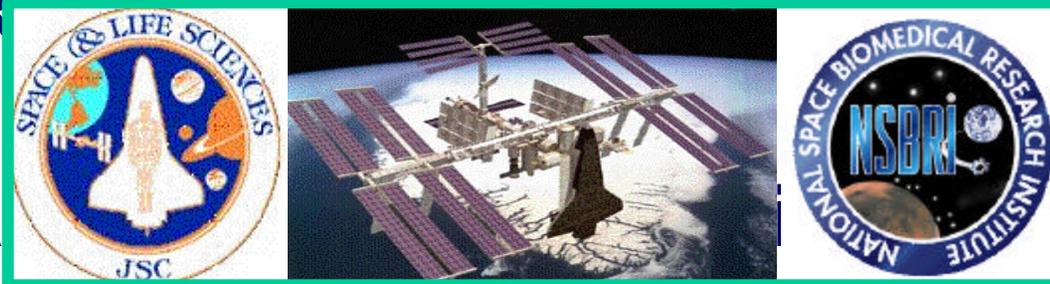
- ✓ In order to implement the NASA/NSBRI partnership we have analyzed our functional units/laboratories

- Direct Flight Readiness Review (FRR) and certification

- FRR Support

- Research and Operations Support

- ✓ NASA and NSBRI continue to have significant responsibilities and

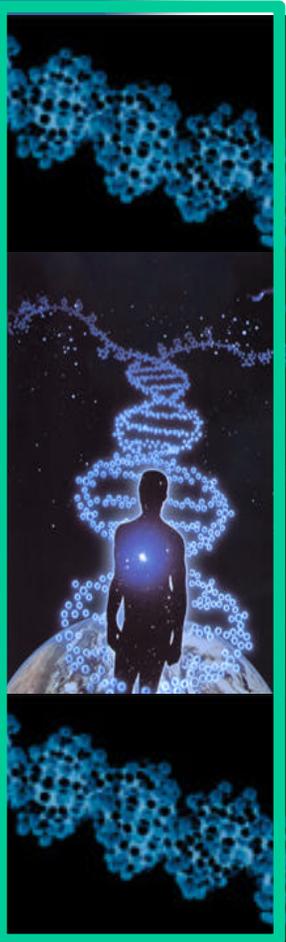


Identifying Responsibilities

- ✓ **Analyzed ability of NSBRI to directly participate in these functions**

In the 24 functions/laboratories

- **Only 2 are not suitable for NSBRI involvement (Earth Sciences and Orbital Debris)**
- **22 areas identified feasible for immediate collaborative team member support**
- **5 areas identified as short-term (0-1 year) leadership feasible**
- **6 additional areas identified as medium-term (2-3 years) leadership feasible**



Process Improvement

✓ The following processes are new or modified

S
L
S
D

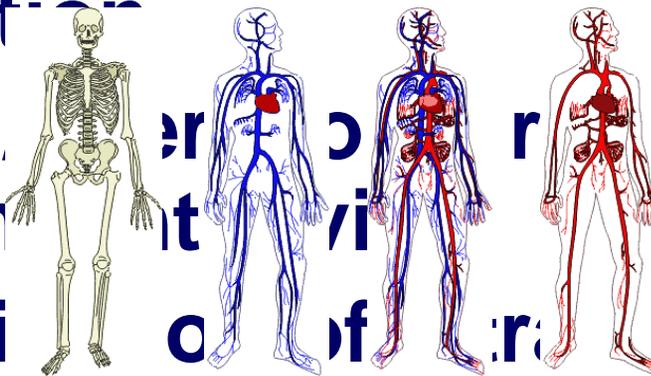
➤ Critical Path Research Plan development and utilization

➤ Risk assessment, quantification, and management

➤ Countermeasure development and verification

➤ Clinical independent research

➤ Consolidation of natural discipline



Increase in Resources

✓ Base Program

- Additional \$4M applied to NSBRI in FY00
- Additional \$6M applied to NSBRI in FY01
(\$20M total)

S

L

✓ Augmentation

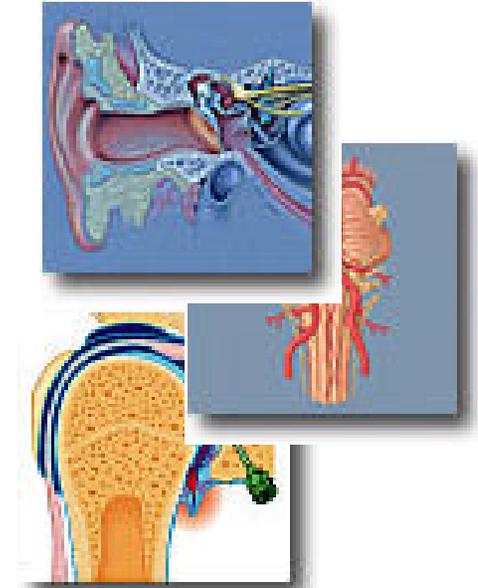
- Additional increase in NSBRI activities and manpower
- Support overall Bioastronautics activities
- Support complementary work at other NASA centers

D

✓ Re alignment of civil servant skill mix

Integrated Bioastronautics Laboratory

✓ Establish an integrated, state-of-the art laboratory that provides the health care, performance training, rehabilitation, research, and educational outreach necessary to support the NASA Human Operations in Space mission *while* directly involving the NSBRI and the external scientific community



Objectives

➤ **Develop and implement a comprehensive capability that supports the maintenance of health care and performance for astronauts on-orbit as well as on the ground (pre- and post-flight).**

S
L
S
D ➤ **In association with the National Space Biomedical Research Institute (NSBRI) provide the facilities that support the development and implementation of a comprehensive biomedical research program that understands and mitigates the physical, physiological, and psychological risks associated with human space flight**

➤ **Provide an environment which brings the best scientific and technical minds in the country (and internationally) together to understand and address the issues of human space flight**

Approach

➤ Integrate the separate, but related, functions of astronaut health care, physical training and rehabilitation, biomedical research, health care advanced technology development, and outreach/education into an integrated complex

S
L
S
D

➤ Establish an environment where astronauts, S,



Bioastronautics Laboratory

- ✓ **Single, integrated facility that supports the human elements of space flight**
 - ✓ **Space medicine**
 - ✓ **Biomedical research laboratories/baseline data**
 - ✓ **Ground/flight research and operations integration**
 - ✓ **Human factors/bioengineering**

S
L
S
D

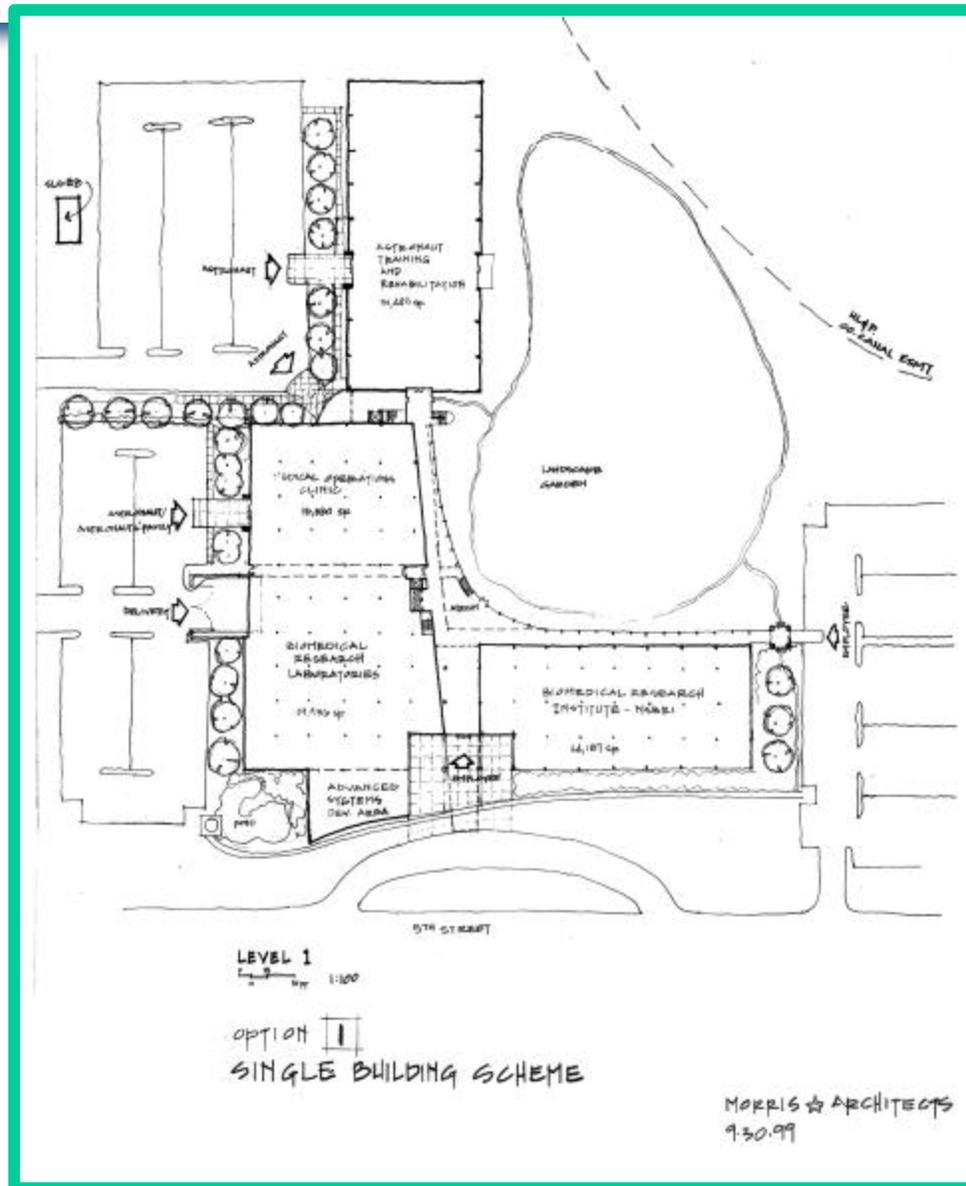


- System/Informatics Research
- ✓ **Re-habilitation, isolation, autonomous**

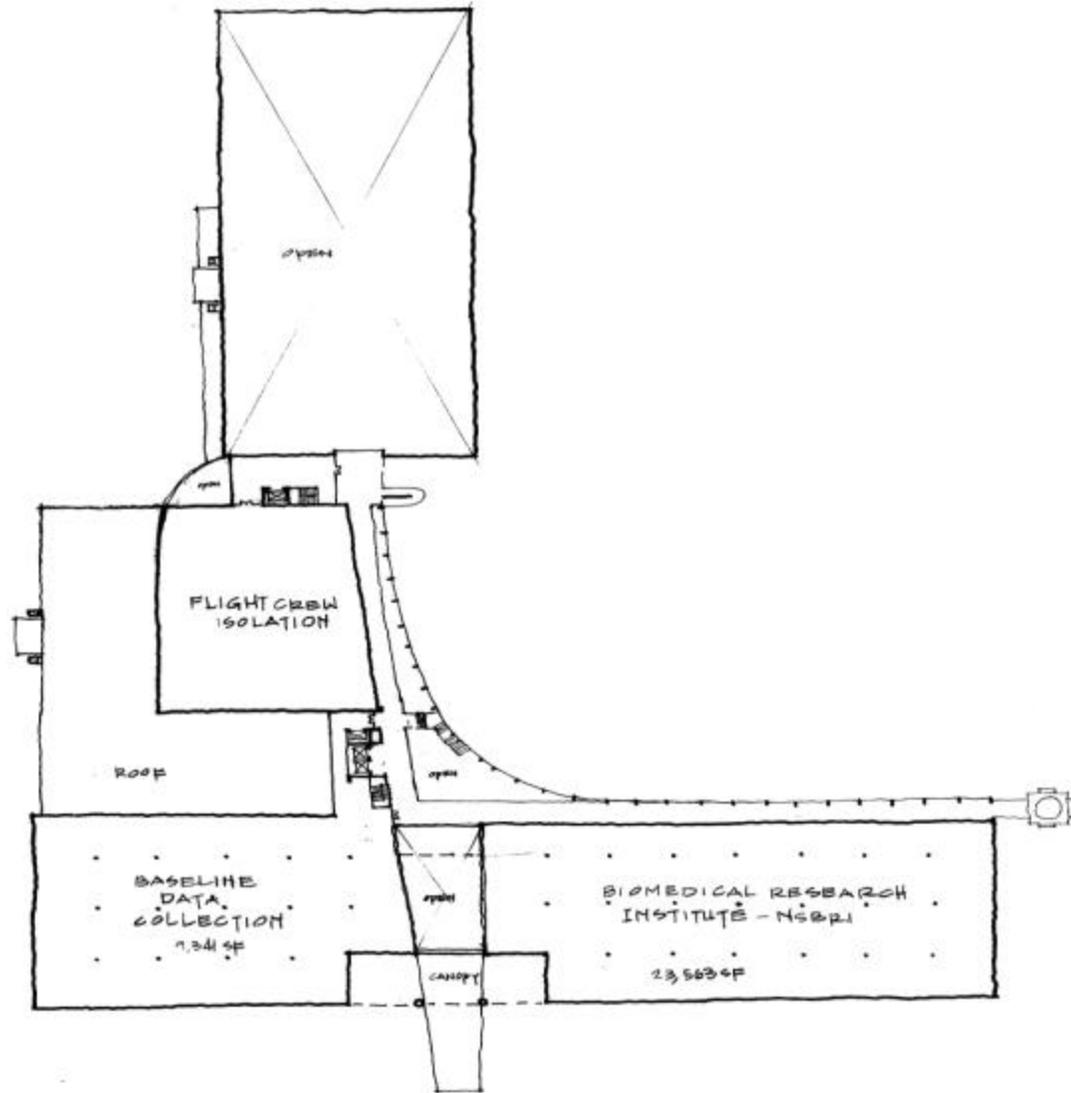
Fifth Street Elevation Option 1

Bioastronautics Laboratory

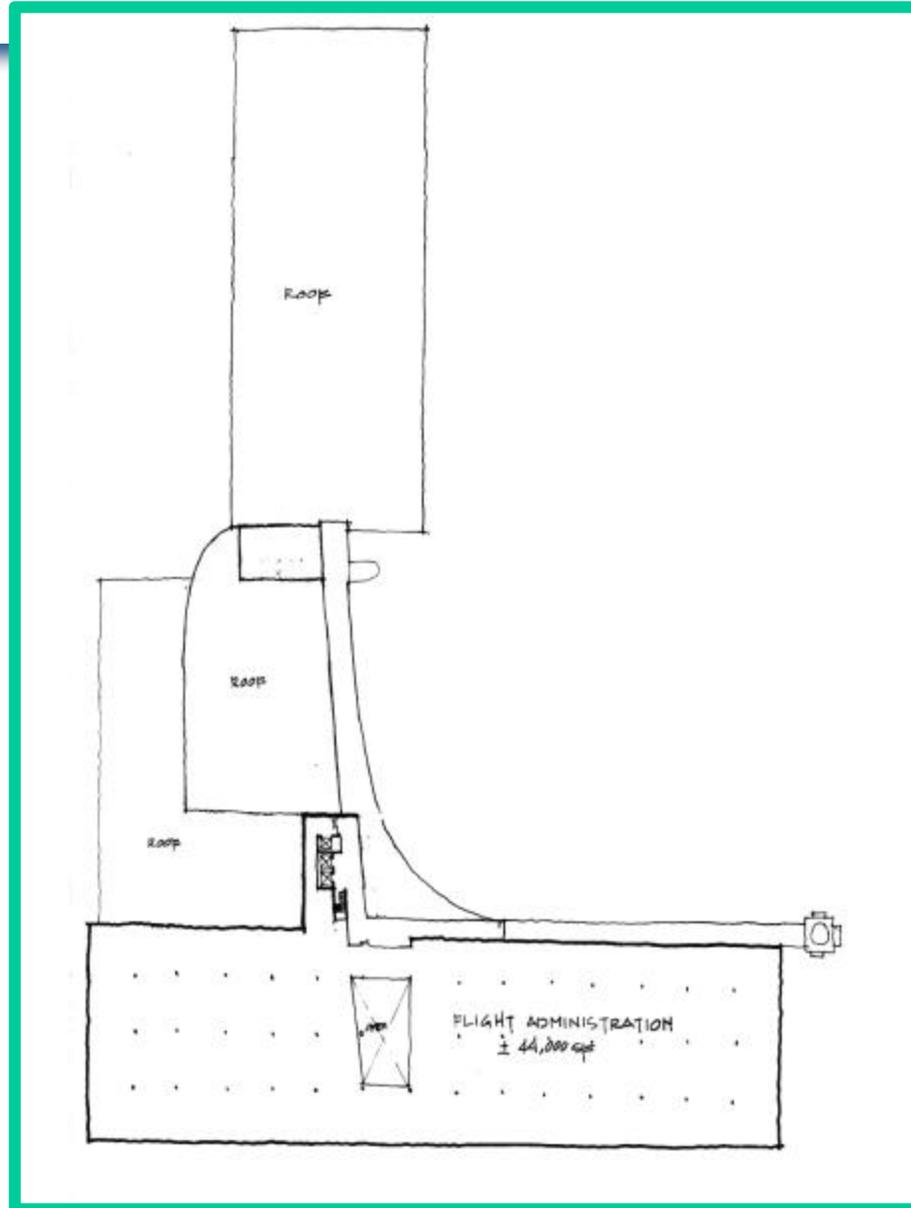
S
L
S
D



Bioastronautics Laboratory



Bioastronautics Laboratory



Facility - Status

- ✓ Initial requirements developed in order to do a preliminary feasibility/cost study

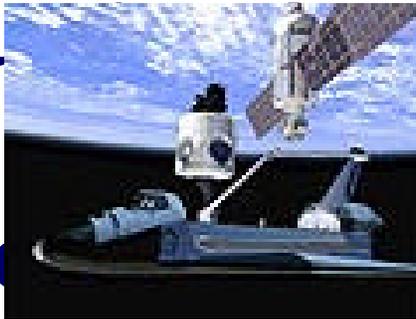
S ✓ 15% design nearing completion, final design in FY00

L

S ✓ Construction in FY01-02 (occupancy fall FY02)

D

- ✓ Pursuing unique arrangements



- ✓ Initiation of internal approval

Implementation Schedule

✓ Major Bioastronautics Milestones

S

Date

L

S

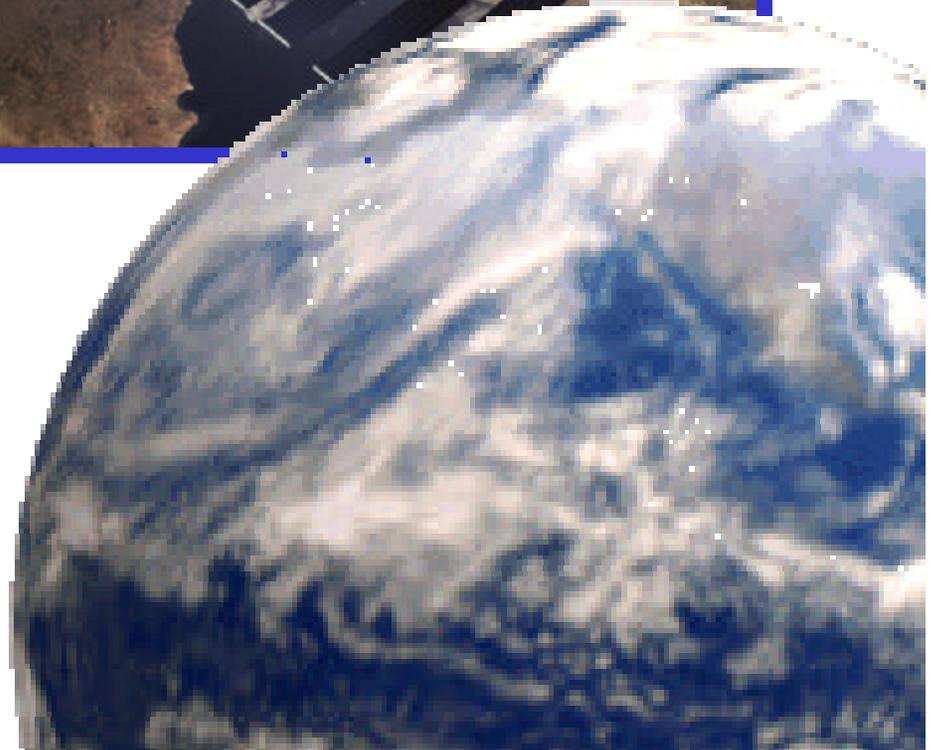
D

- Begin selected implementation (based on increased baseline) 10/99 Complete strategic planning (based on OMB pass back) 12/99
- Decide on Bioastronautics Laboratory approach 1/00
- NSBRI initiation of major augmentation activities 1/00
- Complete initial tactical planning 3/00
- Complete HQ/JSC organizational changes

Summary

S
L
S
D

Bioastronautics provides an integrated approach with measurable deliverables leading to safer and more productive human space operations, with benefits for the health and well-being of people on Earth



S
L
S
D

