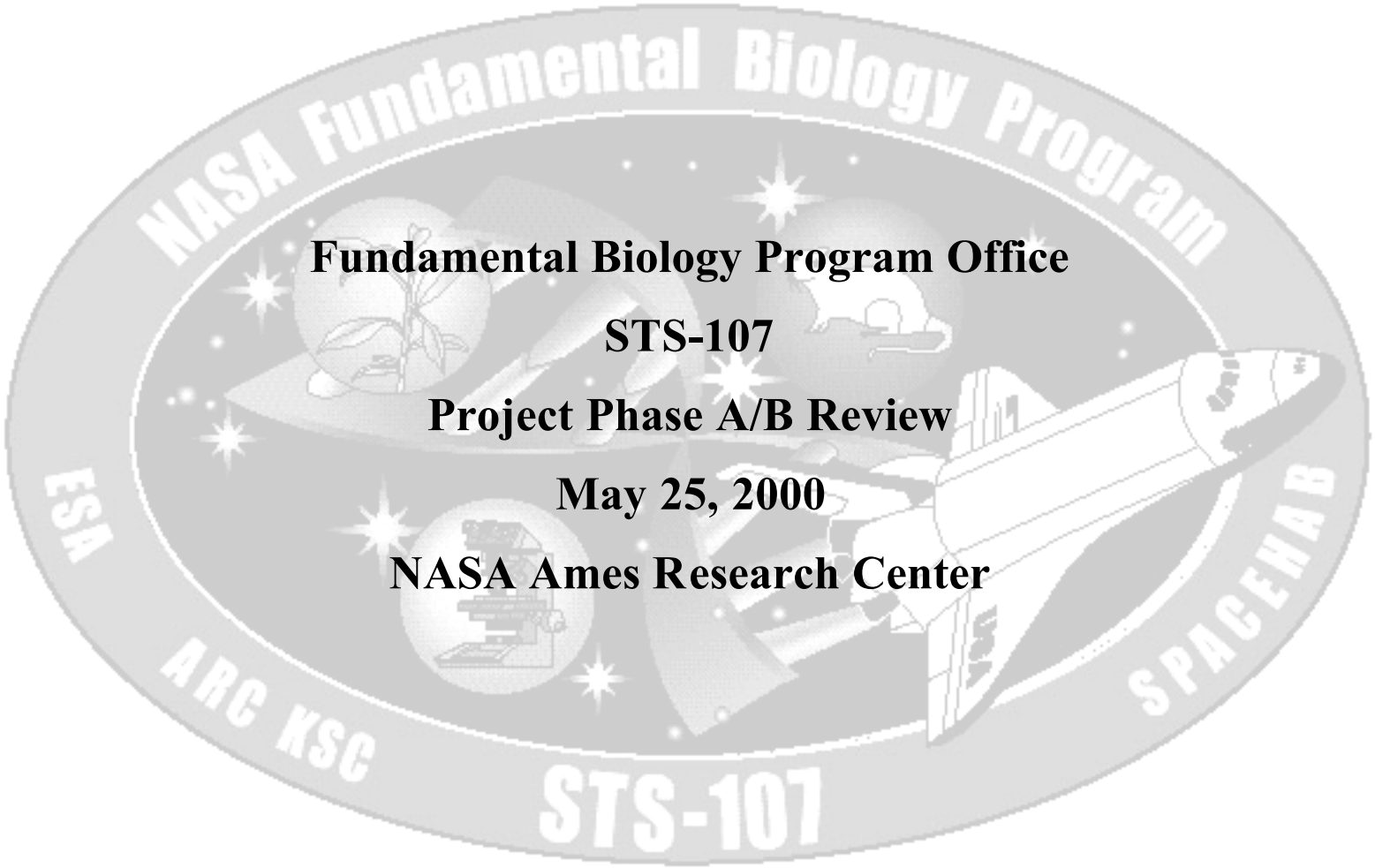


Fundamental Biology Program Office

STS-107

Project Phase A/B Review

May 25, 2000

NASA Ames Research Center

Agenda

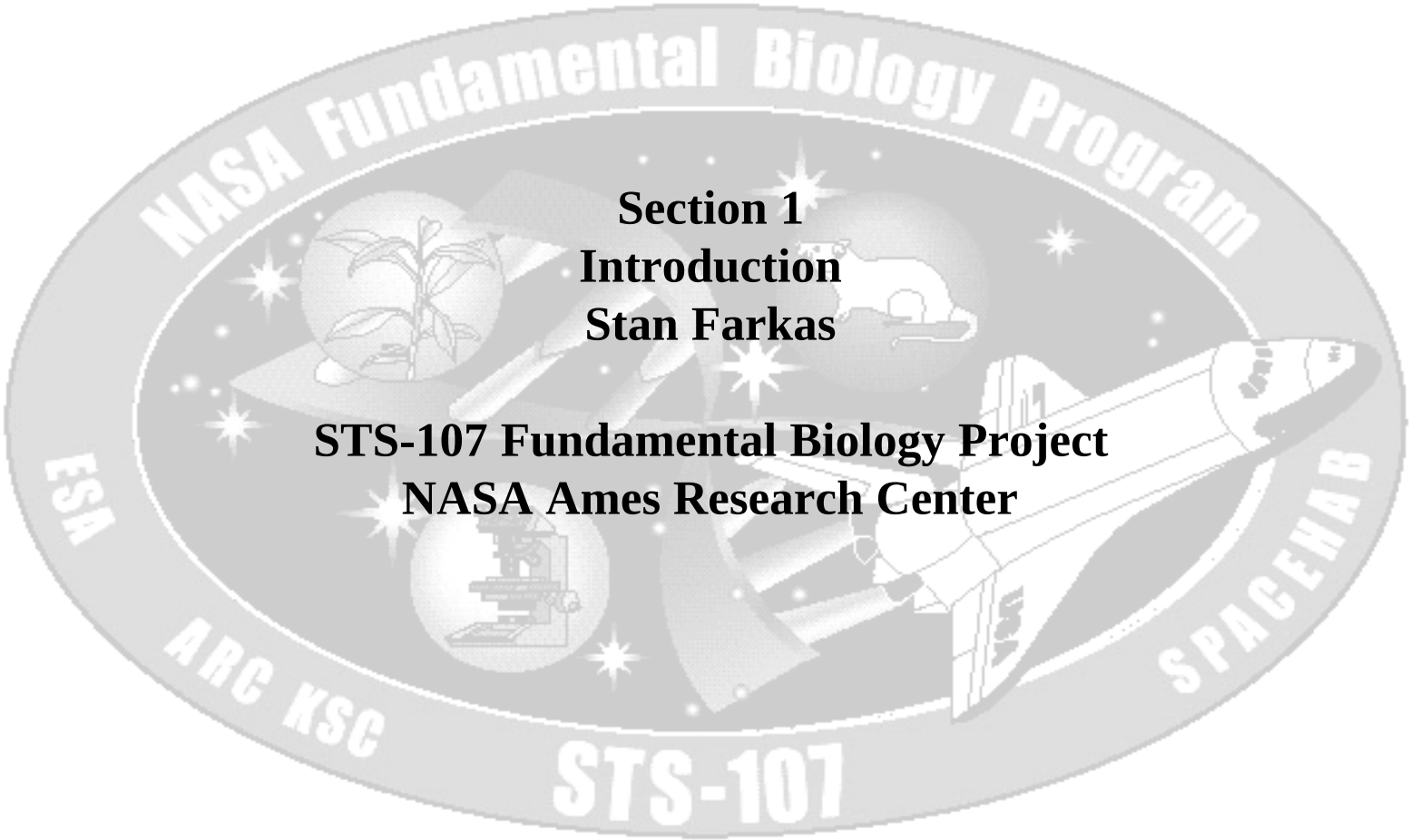
Ames Research Center

1) Introduction	Stan Farkas
2) Overview	Stan Farkas
3) Goals & Objectives	Stan Farkas
4) Project Requirements	Stan Farkas
5) Experiment Assignment Status	Stan Farkas
6) Payload Configuration	Stan Farkas
7) Science	Paula Dumars
8) Hardware Status	Rick Hoopes
9) Operations	Rick Hoopes
10) Crew Training	Steve Ormsby

Agenda

Ames Research Center

11) Project Stowage	Fernando Revilla
12) Verification	Selim Ibrahim
13) SS&MA	Keith Jaquillard
14) Lessons Learned	Stan Farkas
15) Risk Management	Stan Farkas
16) Development Status	Stan Farkas
17) KSC - Hasenstein	April Boody
18) KSC - Sack	Roberteen McCray
19) Summary	Stan Farkas



Section 1
Introduction
Stan Farkas

STS-107 Fundamental Biology Project
NASA Ames Research Center

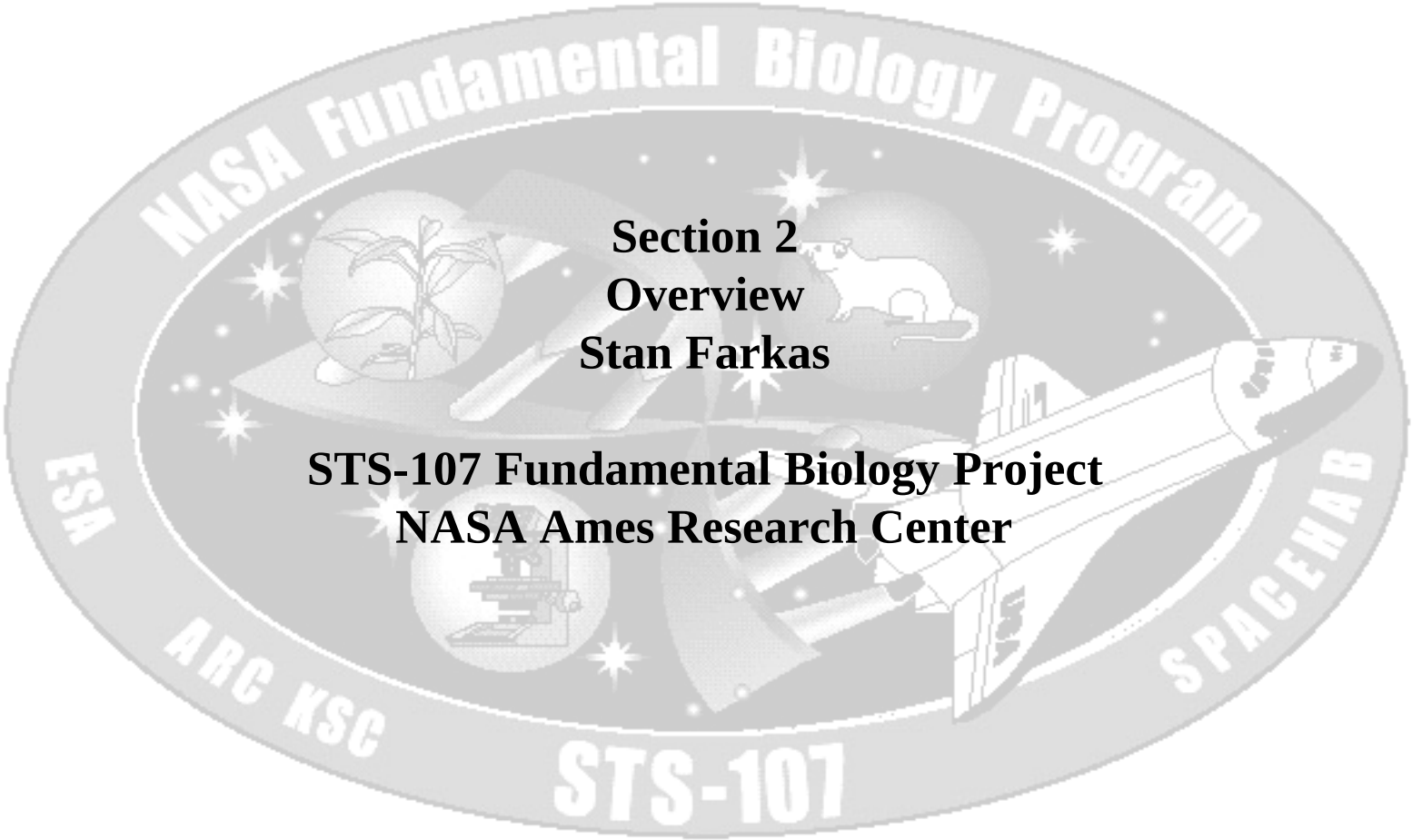
Introduction

- **Meeting Logistics**
- **Purpose of Phase A/B Project Status Review**

Phase A/B Project Status Review

- **Purpose: To present the status of the project to NASA Ames management and other key personnel. Areas reviewed are defined in the agenda**

- **Goal: To obtain authority from the ARC Life Sciences Division Project Control Board to proceed to Project Phase C per ARC ISO Document AI-02319**



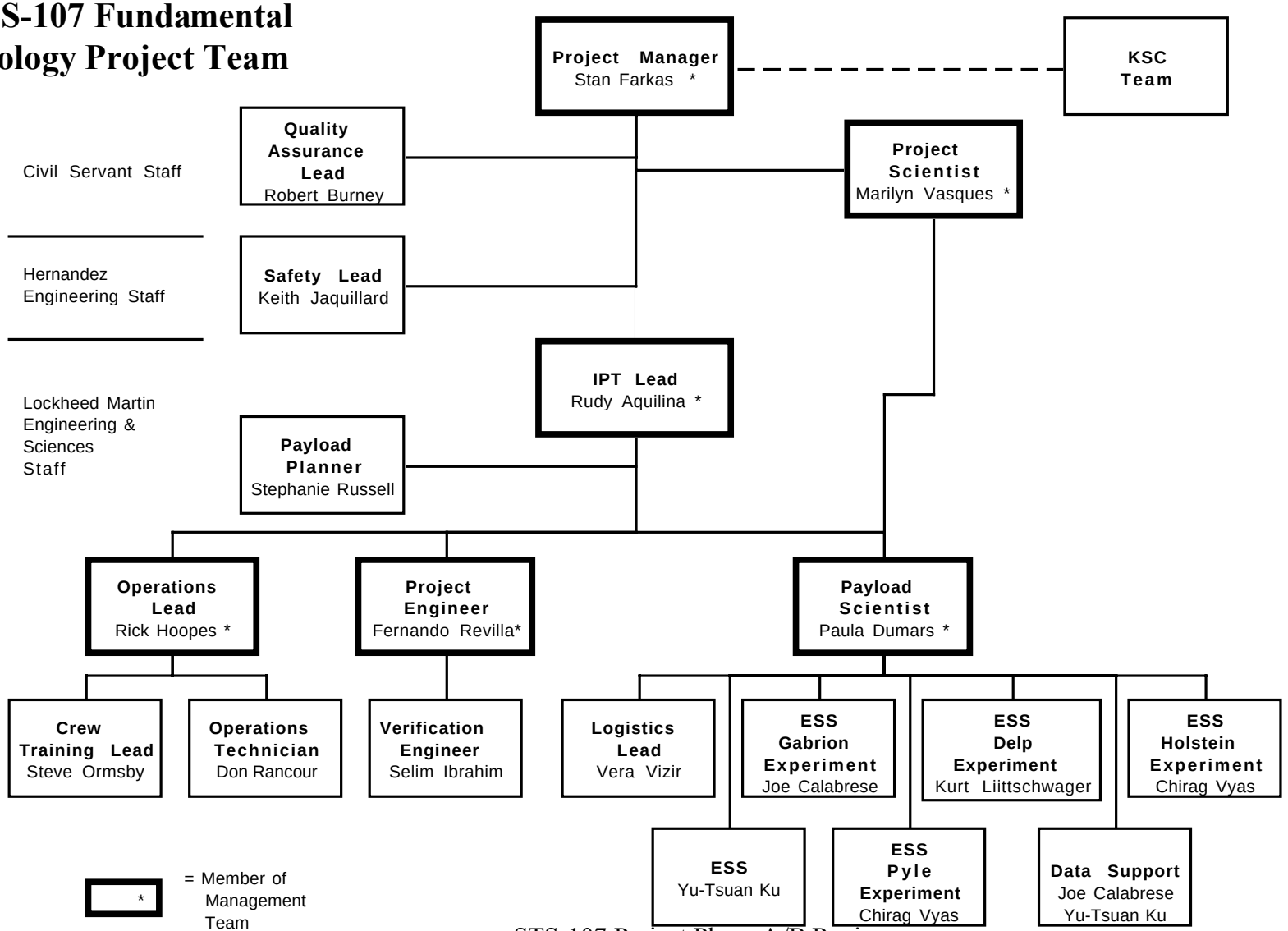
Section 2
Overview
Stan Farkas

STS-107 Fundamental Biology Project
NASA Ames Research Center

STS-107 Fundamental Biology Project Mission Statement

To Facilitate Fundamental Biology Space Flight Research on Shuttle Mission 107 to Further Understand How Living Systems Respond to Microgravity

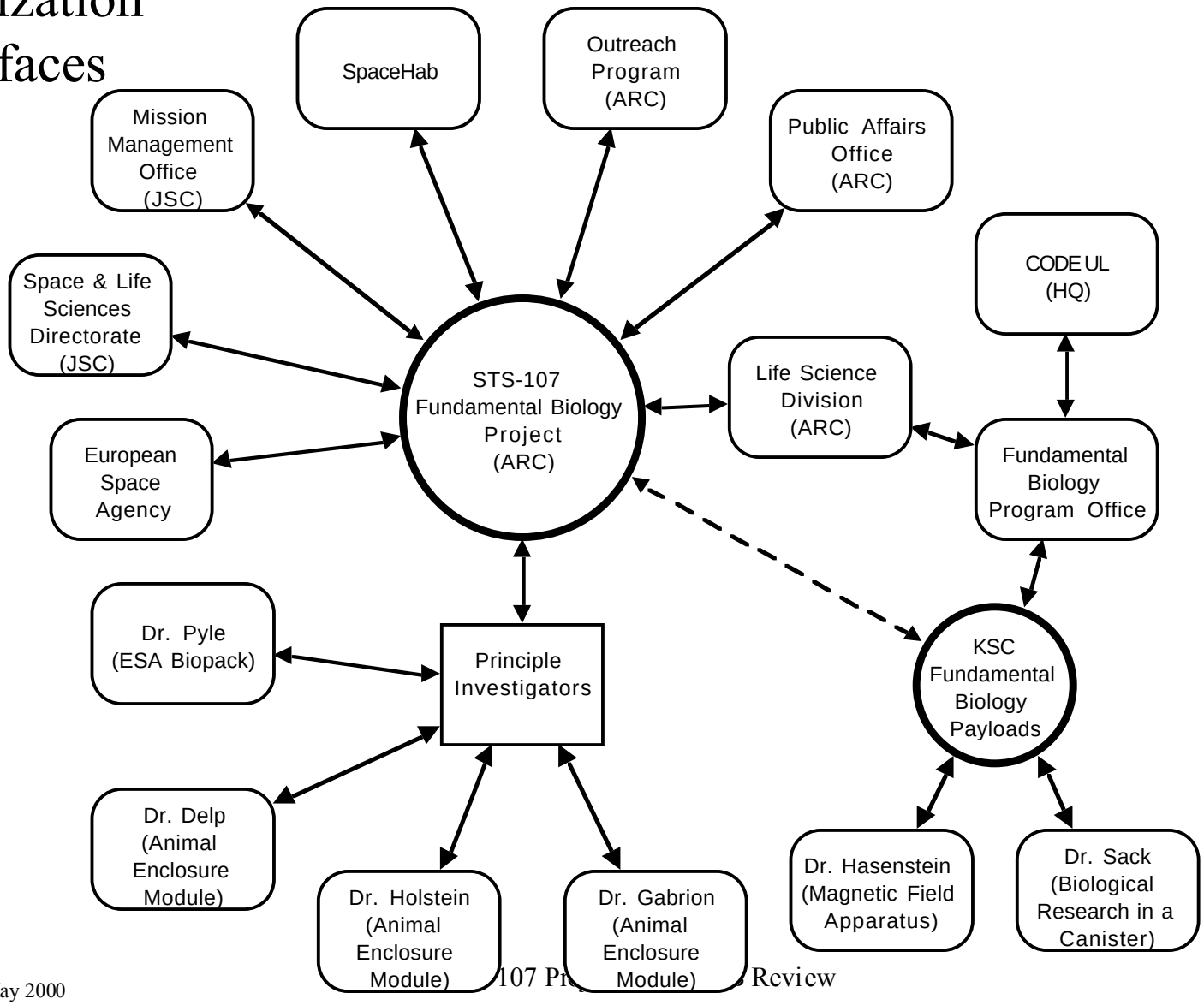
STS-107 Fundamental Biology Project Team



- **KSC STS-107 Team**

Guy Etheridge	**KSC Flight Experiments Lead**
David Cox	**Project Manager (Hasenstein Experiment)**
April Boody	**Project Engineer (Hasenstein Experiment)**
Bridgit Higginbotham	**Project Manager (Sack Experiment)**
Roberteen McCray	**Project Engineer (Sack Experiment)**

Organization Interfaces



Ames Research Center

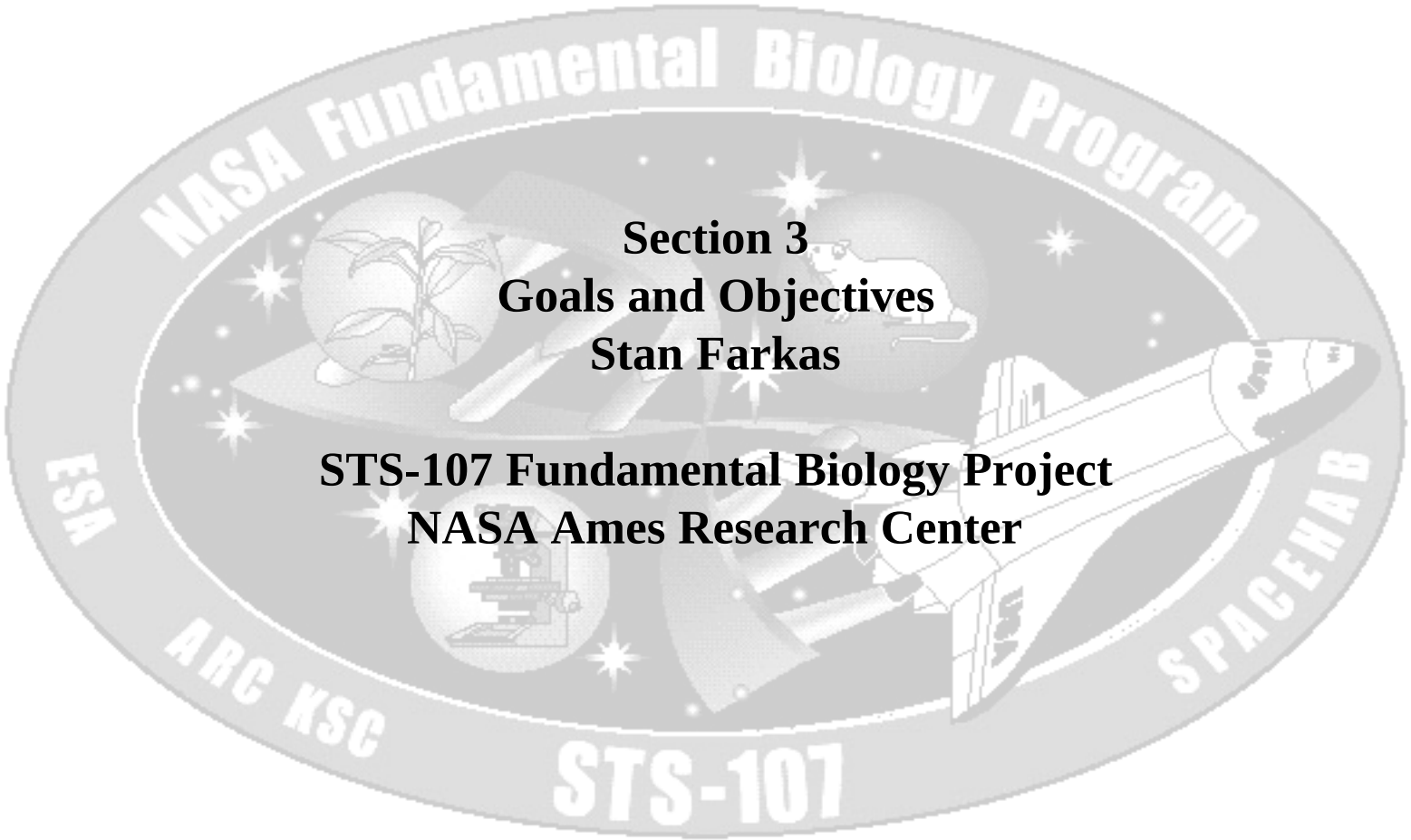
- **STS-107 Fundamental Biology Project Supports the NASA Strategic Plan**
  - **NASA Mission:**
    - **To advance human exploration, use, and development of space**
  - **Human Exploration and Development of Space Enterprise Goal:**
    - **Expand scientific knowledge**
  - **Fundamental Biology Program Goal**
    - **Effectively use the microgravity of space to enhance our understanding of the fundamental biological processes**

- **Applicable Documents**
  - **NASA Policy Directive: 1000.1a. NASA Strategic Plan, 1998 with 1999 Interim Adjustments**
  - **NASA Procedures and Guidelines: 7120.5A. NASA Program and Project Management Process and Requirements**
  - **ARC ISO 9001 Document: SLO-01, Space Flight Project Management Process**
  - **ARC ISO 9001 Document: AI-02319, Project Phase/Design review Process**
  - **STS-107 Fundamental Biology Project Plan**
  - **TBD NASA/SPACEHAB Buy-Back Agreement**

- **Customers**
  - **Principle Investigators**
    - **Michael Delp, Ph.D.**
    - **Gay R. Holstein, Ph.D.**
    - **Jacqueline Gabrion, Ph.D.**
    - **Barry H. Pyle, Ph.D.**
    - **Fred D. Sack, Ph.D.**
    - **Karl H. Hasenstein, Ph.D.**
  - **NASA Code UL**
  - **NASA Fundamental Biology Project Office**
  - **NASA Mission Management Office**
  - **European Space Agency (ESA)**
  - **SPACEHAB**
  - **Public**

- **Project Planning Activities and Products**
  - **Team Development**
  - **Organization Chart**
  - **Project Plan**
  - **Project Schedules**
  - **Risk Management Plan**
  - **Verification Plan**
  - **SS&MA Plan**
  - **Lessons Learned Assessment**
  - **Submittal of inputs to Program Operating Plan (POP)**

- **Assumptions**
  - **Fundamental Biology payloads are manifested on STS-107**
    - **NASA/SPACEHAB Buy-Back Agreement is Baselined**
  - **Launch date is 4-19-01**
  - **Work to the following SPACEHAB schedules to establish milestones and deliverable dates:**
    - **STS-107 Schedule dated 4-21-00, Launch date 2-22-01**
    - **STS-107 Preliminary Training Schedule Rev. B (Launch 2-22-01) dated 4-6-00**
  - **Fundamental Biology payloads are included on STS-107 Time-line**
  - **Resource allocations required to support Fundamental Biology payloads will be provided by SPACEHAB**
    - **Locations for AEMs, BRIC, MFA/Biotube**
    - **Stowage volume**
    - **Power**
    - **On-orbit crew time**
    - **Crew time for training**



Section 3
Goals and Objectives
Stan Farkas

STS-107 Fundamental Biology Project
NASA Ames Research Center

Goals and Objectives

- **STS-107 Project supports the Fundamental Biology Experiments that have been manifested on the STS-107 flight.**

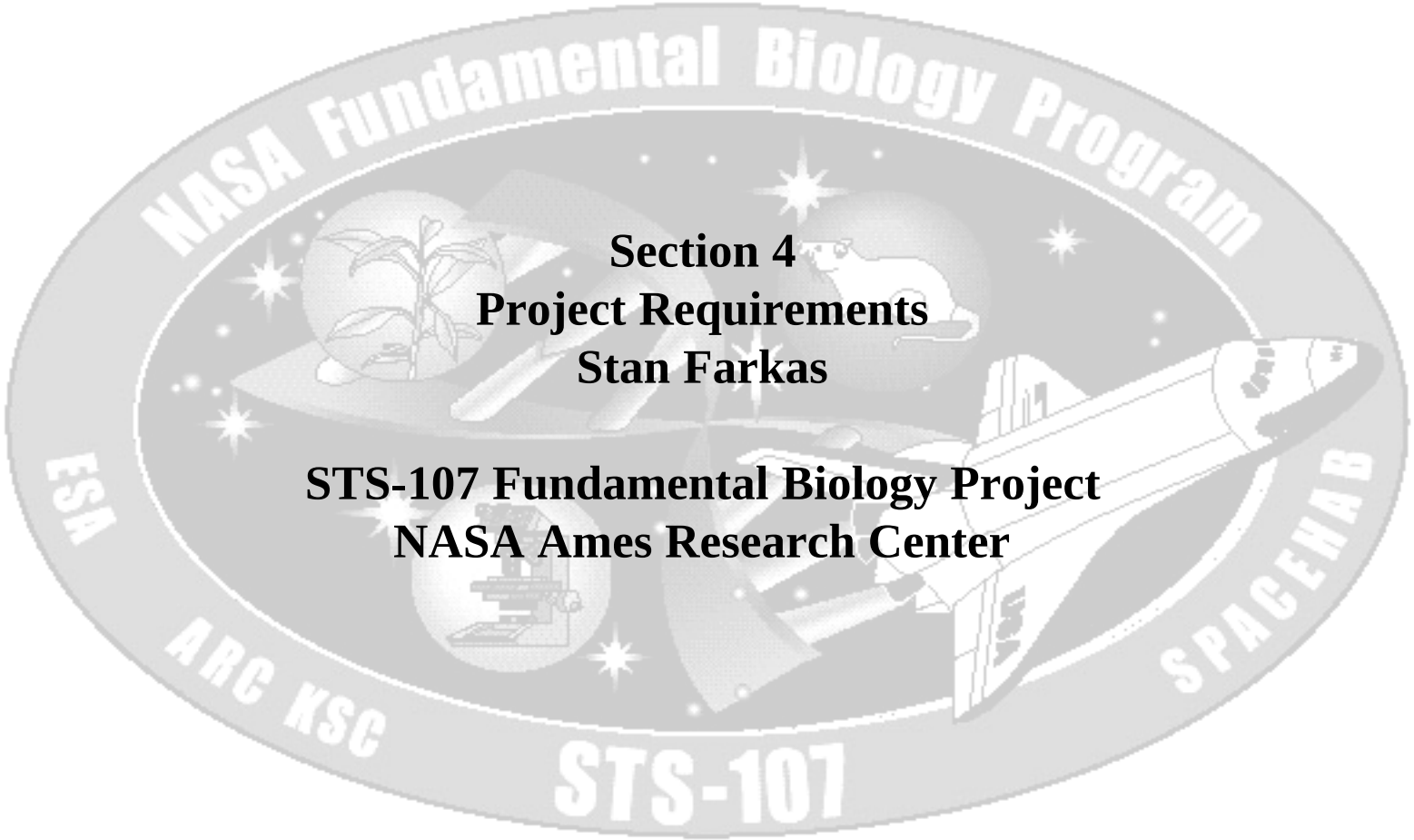
- **The STS-107 Fundamental Biology Project Goals can be summarized as follows:**

  - **Maximize science research return to each investigator**

  - **Conduct research to the highest standards**
    - Confirm Ames Life Science credibility for conducting life sciences research

  - **Build upon and enhance external project interfaces**
    - Effectively manage multiple external project interfaces

  - **Maintain cost effective resource budget management in the areas of manpower, travel, and materials**



Section 4
Project Requirements
Stan Farkas

STS-107 Fundamental Biology Project
NASA Ames Research Center

- **Top Level Requirements**
  - **Primary Fundamental Biology Project Requirements**
    - **Support research on-orbit utilizing the following platforms:**
      - **AEM - Animal Enclosure Module (ARC)**
      - **Biopack (ESA)**
      - **MFA/Biotube - Magnetic Field Apparatus (KSC)**
      - **BRIC - Biological Research in a Canister (KSC)**

- **Top Level Requirements (Continued)**
  - **Project Management Requirements**
    - **Sufficient resources (funds and personnel) shall be provided to maximize probability of mission success.**
      - **Criteria: Sufficient funds and personnel have been allocated to the project.**
    - **Project planning shall be conducted to maximize probability of mission success.**
      - **Criteria: Project Planning activities and products have been developed.**

- **Top Level Requirements (Continued)**
  - **Hardware Requirements (AEM/Biopack)**
    - **AEM H/W design and operations shall meet science requirements as defined in individual Experiment Requirements Document (ERD).**
      - **Criteria: AEM hardware maintains the health and welfare of adult rats in microgravity as demonstrated in past flights.**
    - **AEM CO_2 System shall provide the crew with a safe and rapid means of euthanizing rodents in the event of an animal crisis.**
      - **Criteria: The system will be tested and validated prior to flight.**
    - **Biopack hardware shall meet science requirements as defined in the ERD.**
      - **Criteria: Successful completion of Experiment Sequence Test.**

- **Top Level Requirements (Continued)**
  - **Science Requirements**
    - **Experiment designs shall be defined**
      - **Criteria: Experiment Requirements Document have been written, released & baselined.**
    - **Experiment design shall be approved**
      - **Criteria: Authority to proceed from ARC Life Sciences Division Project Control Board.**
    - **On-Orbit operations shall be conducted**
      - **Criteria: Completion and implementation of preflight preparations and mission timeline.**
    - **Experiment data shall be disseminated to PI teams**
      - **Criteria: Post-flight samples are received by PIs.**

- **Top Level Requirements (Continued)**
  - **Operations Requirements**
    - **Hardware shall be fabricated, modified, and refurbished to meet objectives identified in the Experiment Requirement Documents.**
      - **Criteria: Turnover flight hardware to SPACEHAB prelaunch.**
    - **Hardware shall be prepared to support crew training.**
      - **Criteria: Completion of dry runs and hands on training.**
    - **Training of crew shall be supported by STS-107 Fundamental Biology Project personnel.**
      - **Criteria: Release crew training proficiency criteria.**
  - **Safety Requirements**
    - **The identification and mitigation of hazards shall be accomplished to achieve mission success for the STS-107 SPACEHAB mission.**
      - **Criteria: Completion of Payload Safety Process (Phase review cycle)**

Master Schedule

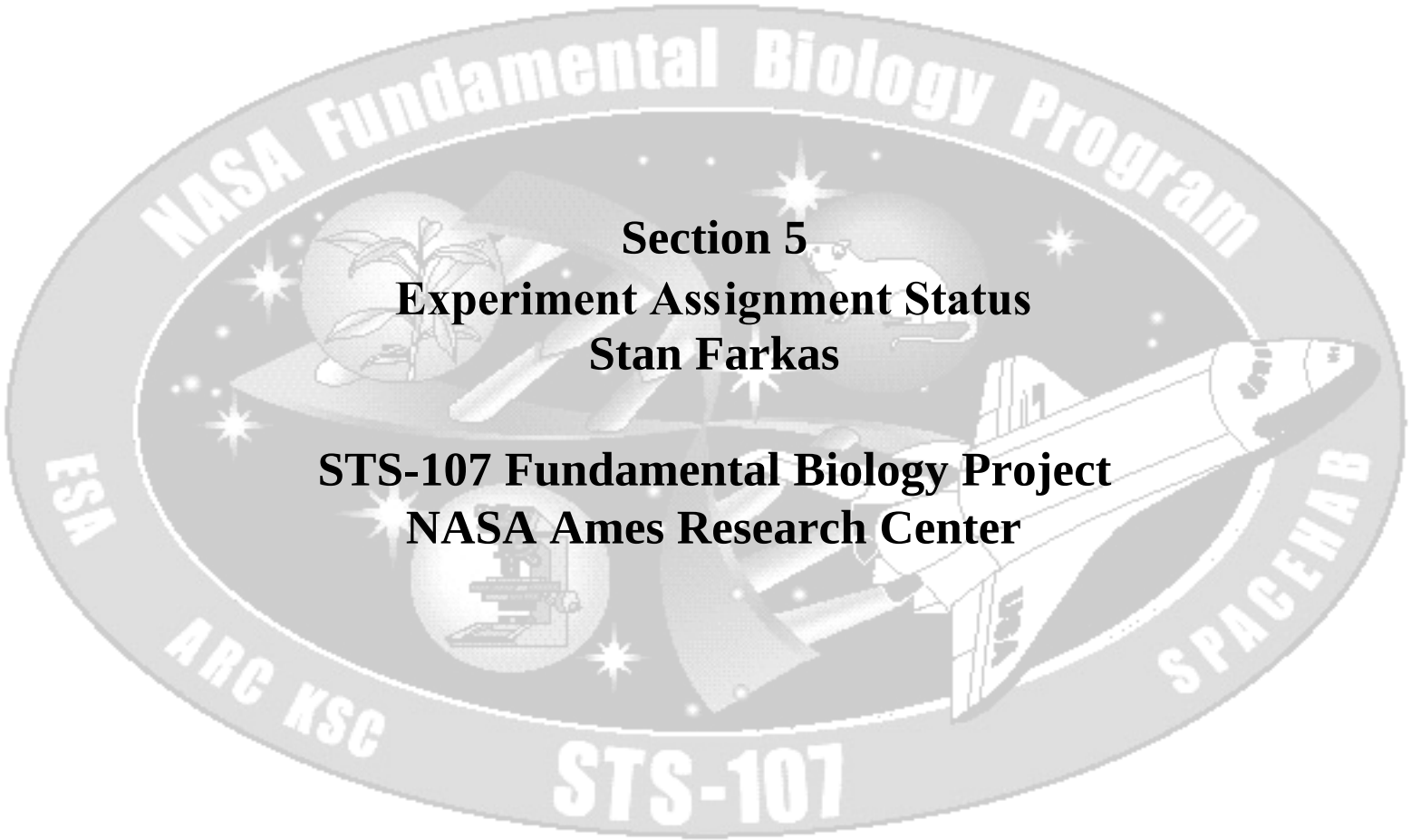
Available
at review

- **Schedule (Continued)**
  - **Network Diagram (in meeting room)**
  - **Gantt Chart (in meeting room)**

Project Requirements

Ames Research Center

- **List of Deliverables**
  - **Generic SPACEHAB Deliverable Schedule (available at review)**
- **Resources (materials, facilities, personnel)**
  - **ARC- Payload Receiving Facility for all PI teams, ARC facilities as needed for PI teams, staff /materials/equipment/ flight hardware for FRESH-02, staff/materials/equipment for Pyle**
  - **KSC-Launch Site Support Facility-preflight/postflight facilities for all PI teams, staff/materials/equipment/flight hardware for Sack/Hasenstein,**
  - **ESA-Flight H/W and integration for Pyle**
  - **SPACEHAB-Integration for all PI experiments**



Section 5
Experiment Assignment Status
Stan Farkas

STS-107 Fundamental Biology Project
NASA Ames Research Center

Experiment Assignment Status

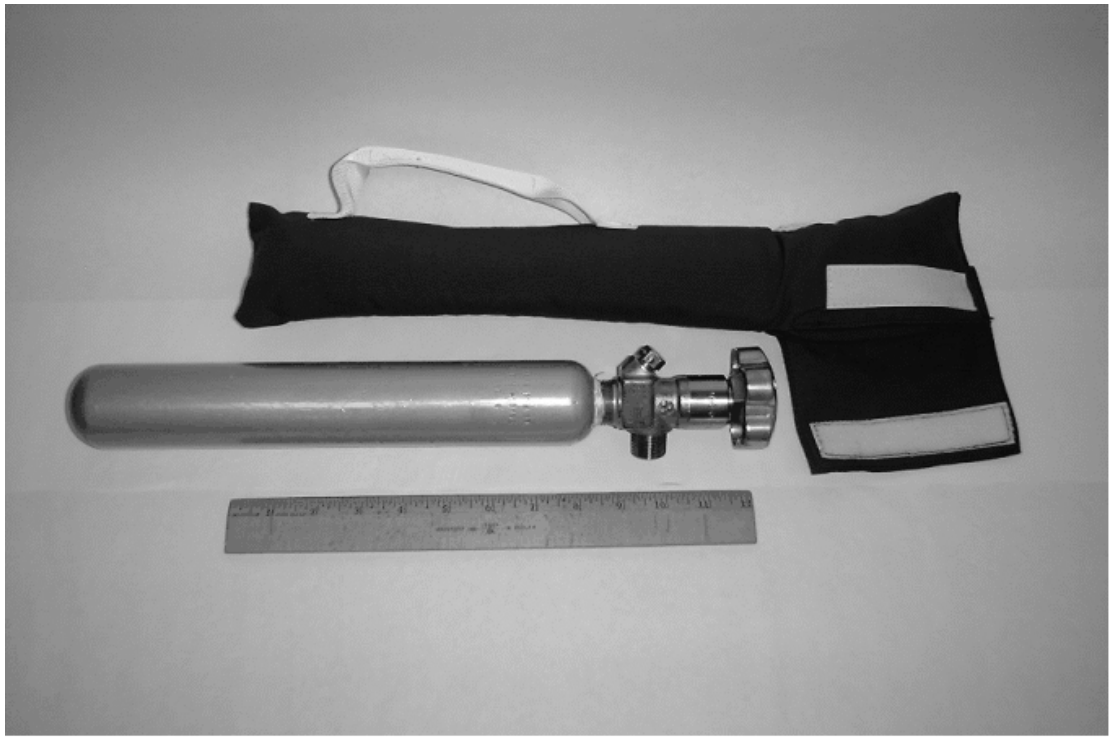
Ames Research Center

- **Fundamental Rodent Experiments Supporting Health (FRESH-02)**
  - **Arterial Remodeling and Functional Adaptations Induced by Microgravity; Michael Delp, Ph.D. , Texas A&M University**
    - **Hardware: Animal Enclosure Module**
    - **Status: Funded; Manifested per Buy-Back Agreement**
  - **Anatomical Studies of Central Vestibular Adaptation: Neurolab Completion Proposal; Gay R. Holstein, Ph.D., Mt. Sinai School of Medicine**
    - **Hardware: Animal Enclosure Module**
    - **Status: Funded; Manifested per Buy-Back Agreement**
  - **Choroidal Regulation Involved in the Cerebral Fluid Response to Altered Gravity; Jacqueline Gabrion, Ph.D., CNRS, Paris (CNES/ESA)**
    - **Hardware: Animal Enclosure Module**
    - **Status: ESA Funded; Manifested per Buy-Back Agreement**

Experiment Assignment Status
ARC Stowage Hardware*

CO_2 Modifications not shown

Experiment Assignment Status
AEM CO_2 Storage Assembly

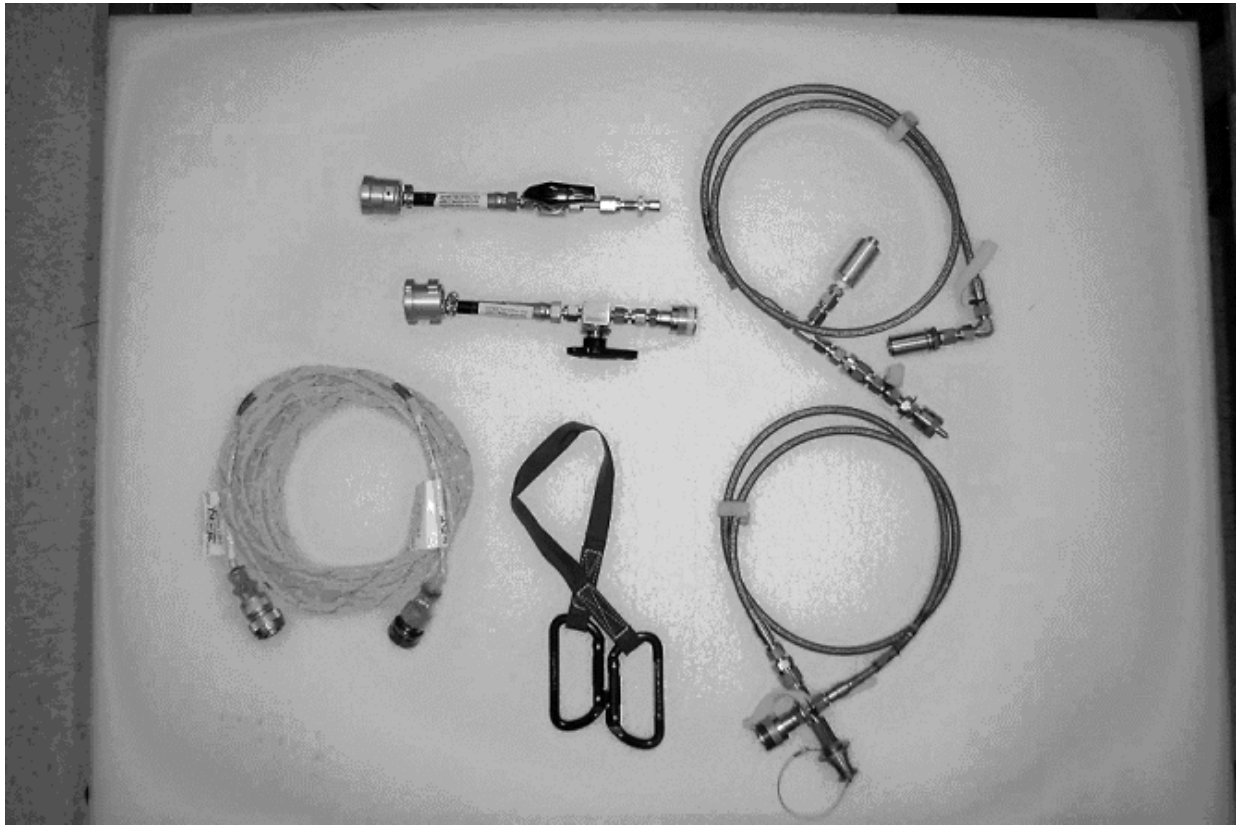


Prototype

Experiment Assignment Status
AEM CO_2 Umbilical Assembly

Prototype

Experiment Assignment Status
IRU Accessories



Experiment Assignment Status
Inflight Refill Unit (IRU)

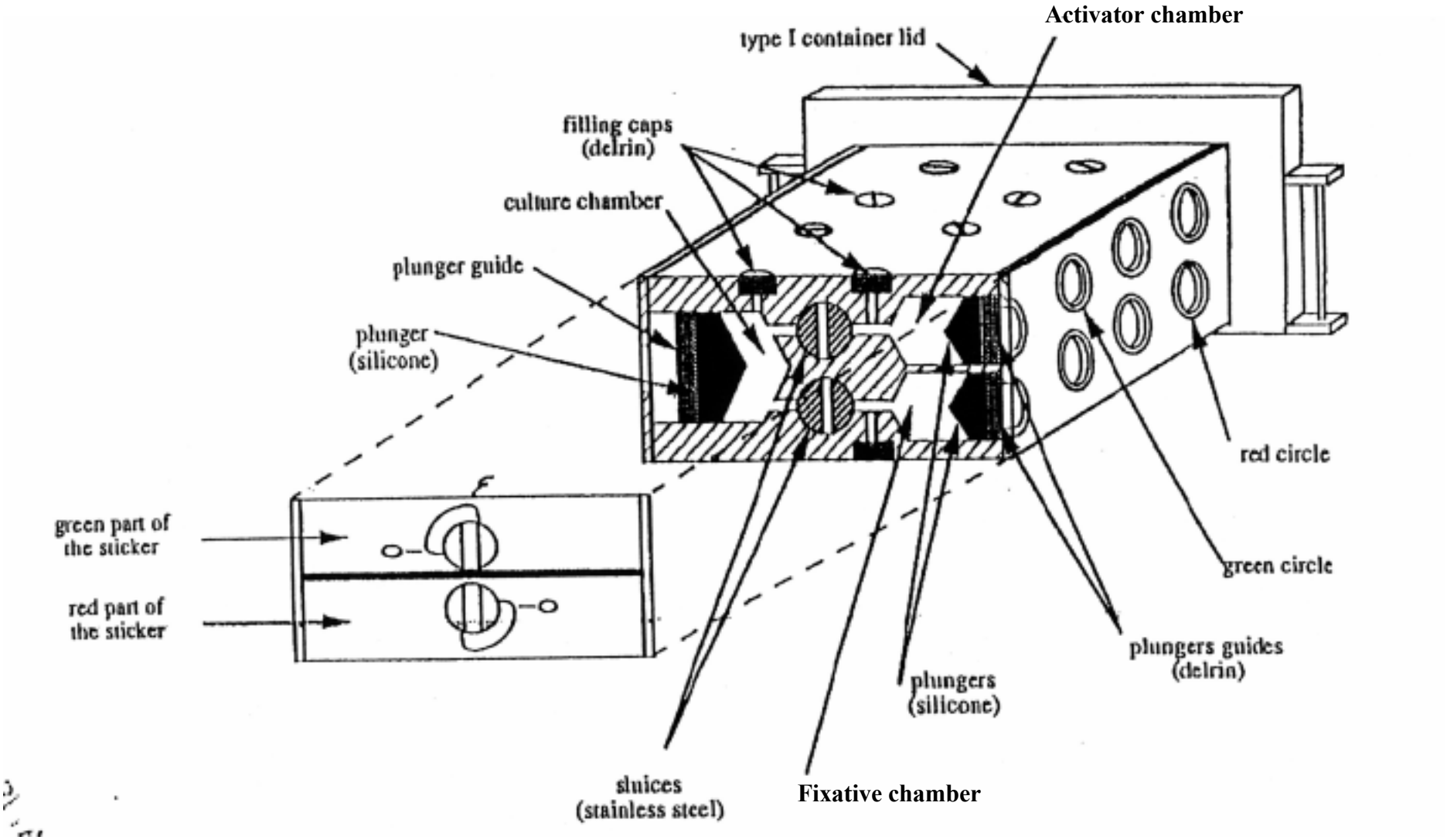
Experiment Assignment Status

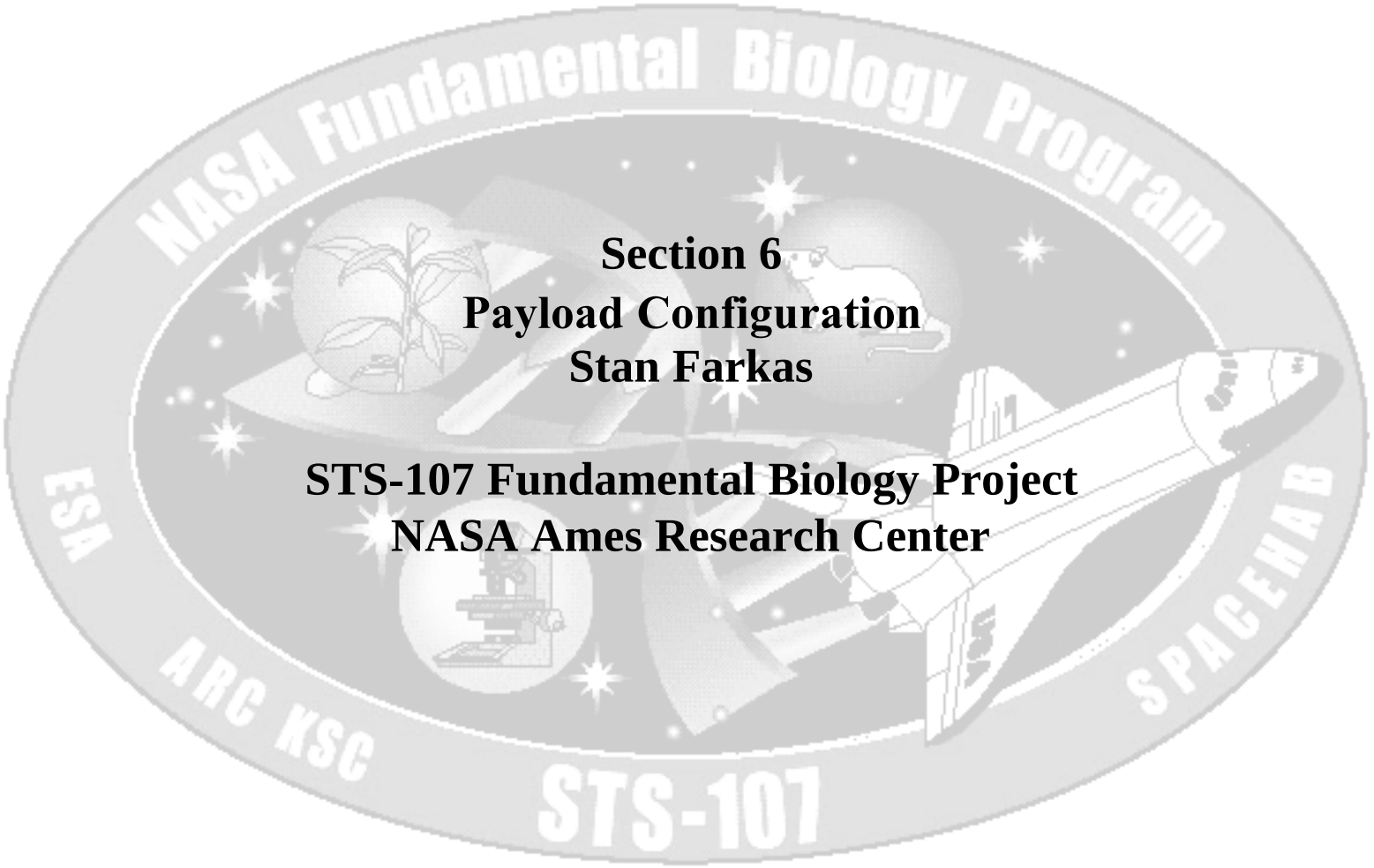
- **Bacterial Physiology and Virulence on Earth and in Microgravity;**
  Barry H. Pyle, Ph.D., Montana State University, Bozeman
  - **Hardware: Biopack (ESA hardware)**
  - **Status: Funded; Manifested**

- **Development of Gravity Sensitive Plant Cells in Microgravity;**
  Fred D. Sack, Ph.D., Ohio State University
  - **Hardware: Biological Research in a Canister (BRIC)**
  - **Status: Funded; Manifested per Buy-Back Agreement**

- **Application of Physical & Biological Techniques in the study of the Gravisensing and Response System of Plants;**
  Karl H. Hasenstein, Ph.D., University of SW Louisiana
  - **Hardware: Magnetic Field Apparatus (MFA/Biotube)**
  - **Status: Funded; Manifested per Buy-Back Agreement**

Experiment Assignment Status
ESA Biopack - Phorbol Unit





Section 6
Payload Configuration
Stan Farkas

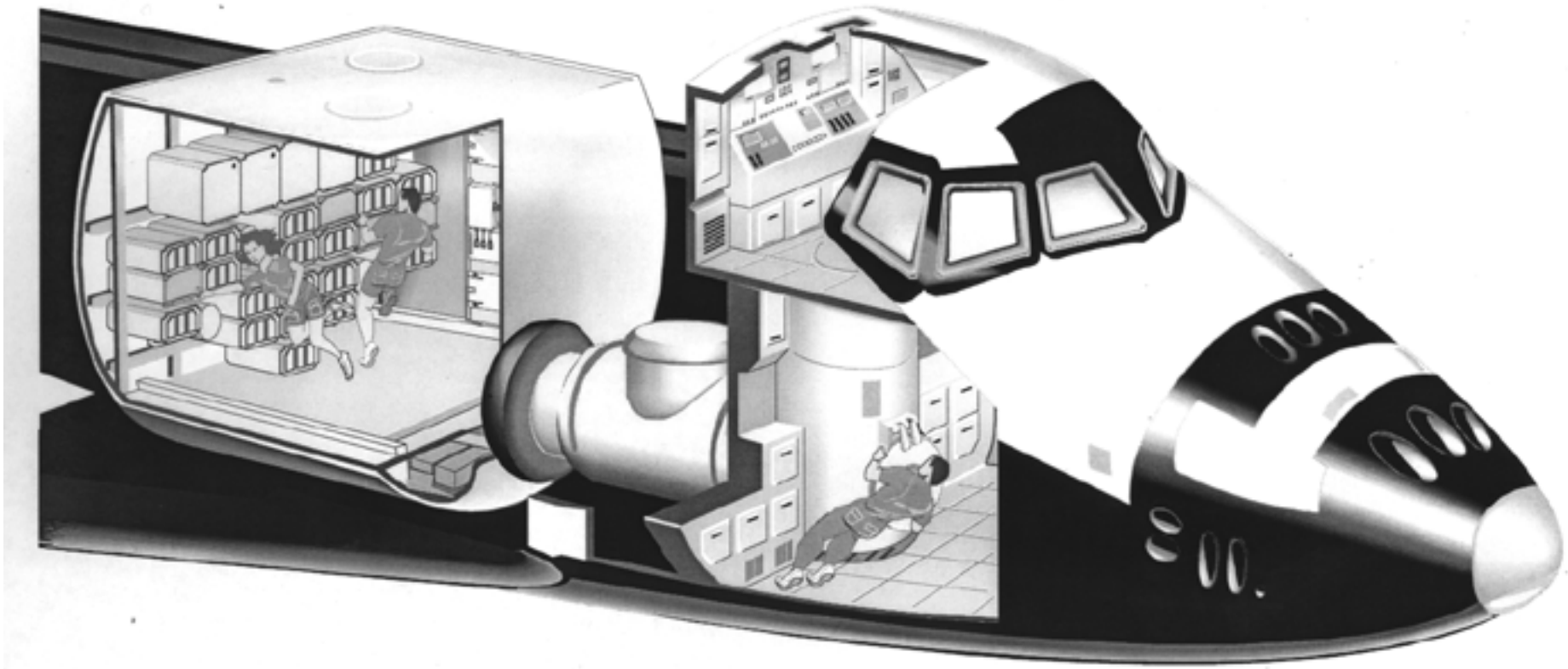
STS-107 Fundamental Biology Project
NASA Ames Research Center

ARC Payload Configuration

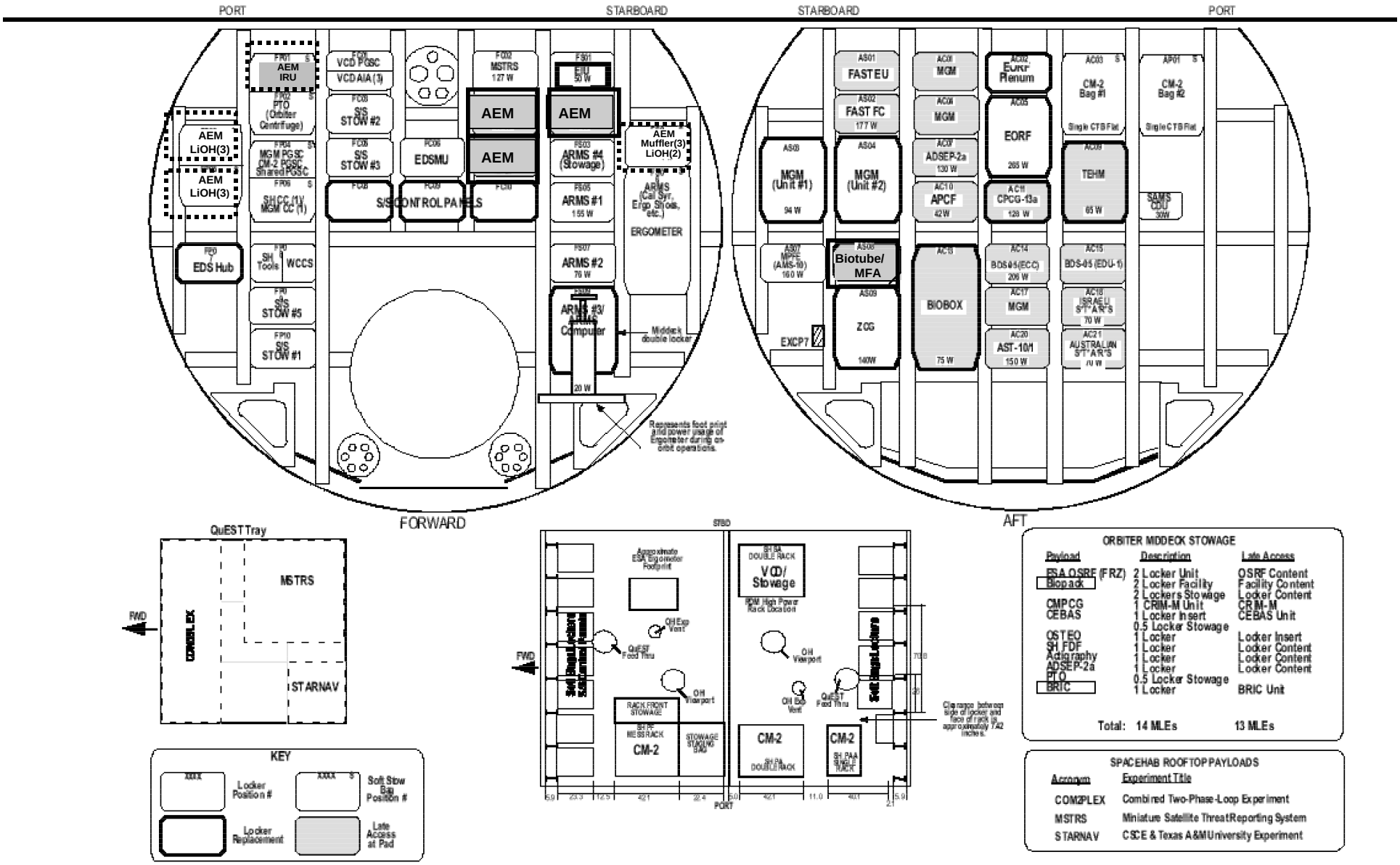
Ames Research Center

- **AEM**
  - **AEMs house the three FRESH-02 experiments and are located on the Forward Bulkhead in SPACEHAB. Final location for ancillary stowage has yet to be finalized, but it is expected to be in SPACEHAB.**
- **ESA Biopack**
  - **The Biopack facility and stowage lockers are located in the Middeck. (ESA is responsible for turning over fully integrated unit.)**
- **BRIC**
  - **The BRIC experiment is located in the Middeck**
- **MFA/Biotube**
  - **MFA/Biotube experiment is located on the Aft Bulkhead in SPACEHAB.**

Payload Configuration



ARC Payload Configuration

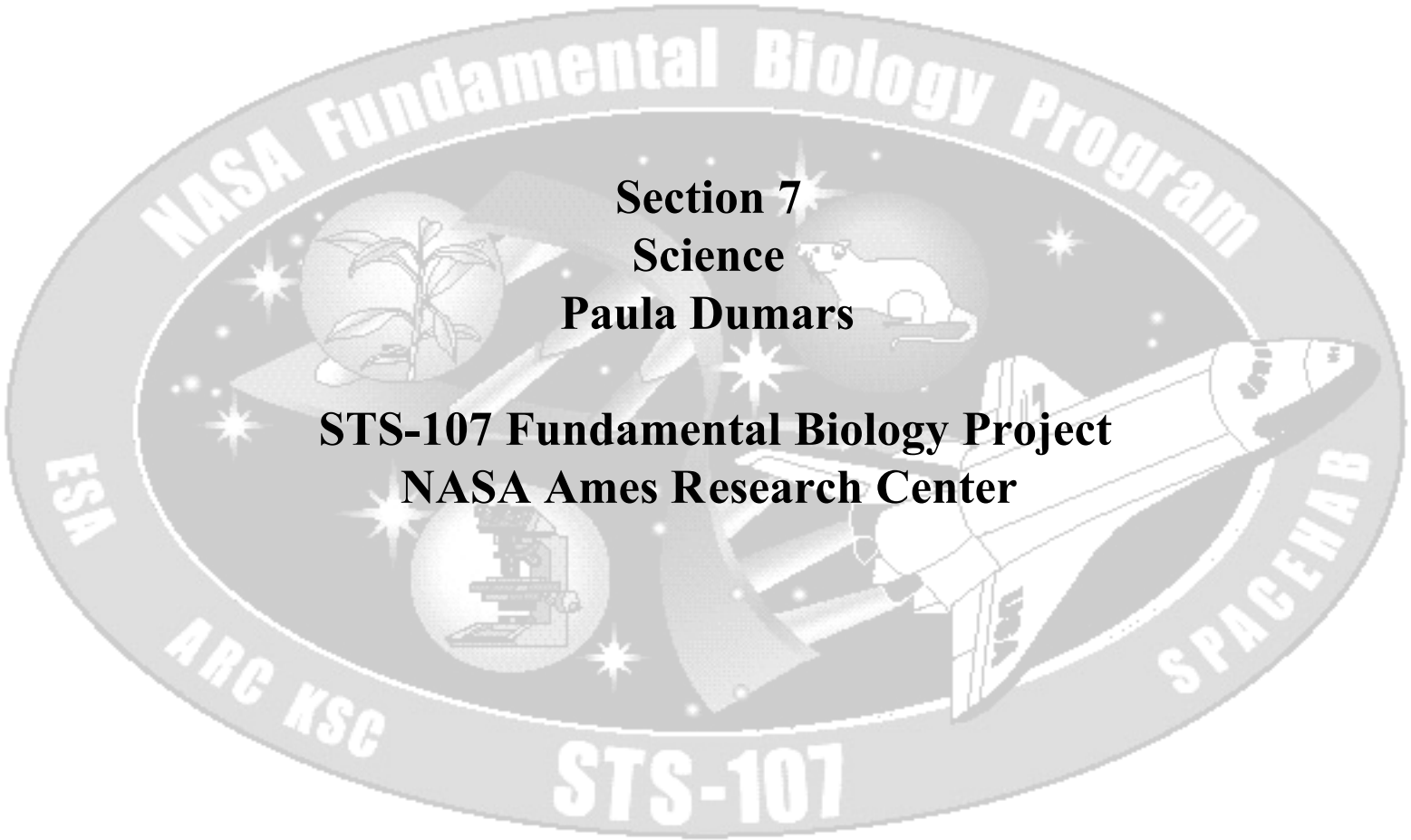


ORBITER MIDDECK STOWAGE

Payload	Description	Late Access
ESA OSRF (FRZ)	2 Locker Unit	OSRF Content
Biopack	2 Locker Facility	Facility Content
	2 Lockers Stowage	Locker Content
CMPCG	1 CRIM-M Unit	CRIM-M
CEBAS	1 Locker Insert	CEBAS Unit
	0.5 Locker Stowage	
OSTEO	1 Locker	Locker Insert
SH FDF	1 Locker	Locker Content
Actigraphy	1 Locker	Locker Content
ADSEP-2a	1 Locker	Locker Content
PTO	0.5 Locker Stowage	
BRIC	1 Locker	BRIC Unit
Total:	14 MLEs	13 MLEs

SPACEHAB ROOFTOP PAYLOADS

Acronym	Experiment Title
COM2PLEX	Combined Two-Phase-Loop Experiment
MSTRS	Miniature Satellite Threat Reporting System
STARNAV	CSCE & Texas A&M University Experiment



Section 7
Science
Paula Dumars

STS-107 Fundamental Biology Project
NASA Ames Research Center

Arterial Remodeling and Functional Adaptations Induced by Microgravity
98-HEDS-02-386

Principal Investigator: Michael D. Delp, Ph. D., Texas A & M University

- **Orthostatic intolerance (dizziness while standing) and orthostatic hypotension (abnormal reduction in arterial pressure) are common problems for astronauts following adaptation to spaceflight and return to Earth.**
  - **Researchers have demonstrated that this is due, in part, to a compromised ability to elevate peripheral vascular resistance and maintain normal blood pressure.**
- **This investigator is looking at the involvement of a vascular mechanism underlying this condition.**

Arterial Remodeling and Functional Adaptations Induced by Microgravity (PI: M. Delp)

Experiment Objectives

- **Determine whether the headward fluid shifts and reduced activity of postural muscles, that occur in microgravity, alter rodent arterial vessel structure and function.**
  - **Arterial vessels are involved in regulating blood flow and arterial blood pressure.**

- **Determine whether arterial smooth muscle atrophy occurs in microgravity and if so, what effect this will have on the ability of arterioles to vasoconstrict.**

Arterial Remodeling and Functional Adaptations Induced by Microgravity (PI: M. Delp)

Experiment Objectives

- **If arterial smooth muscle atrophy and a diminished ability to vasoconstrict are found to occur in microgravity, this would provide evidence for the involvement of a vascular mechanism in the orthostatic cardiovascular dysfunction that occurs following spaceflight.**

- **This knowledge will provide insights essential to the development of counter-measures aimed at attenuating arterial remodeling and reducing the time required for astronauts to readjust to planetary gravitational fields.**

Arterial Remodeling and Functional Adaptation Induced by Microgravity (PI: M. Delp)

Hypotheses:

- **Microgravity will attenuate myogenic (contractile) responsiveness of resistance vessels isolated from skeletal muscle.**
  - **This type of vasoconstriction is primarily involved in maintaining arterial pressure during postural changes from the supine to upright position.**

- **Microgravity will attenuate norepinephrine-mediated vasoconstriction in skeletal muscle arterioles.**
  - **This type of vasoconstriction is primarily induced through the sympathetic nervous system, the dominant system involved in regulating arterial pressure. Contractile response and sensitivity to norepinephrine will be determined.**

- **Microgravity will induce the remodeling of skeletal muscle arterioles, i.e., atrophy of arterial smooth muscle cells.**

Arterial Remodeling and Functional Adaptation Induced by Microgravity (PI: M. Delp)

Hypotheses:

- **Microgravity will enhance skeletal muscle responsiveness to endothelium-dependent vasodilator stimuli.**
  - **Dilatory response and sensitivity to acetylcholine stimuli will be determined.**
  - **This alteration could exacerbate vasoconstrictor deficits.**
- **Microgravity will increase the expression of nitric oxide synthase (NOS) mRNA in skeletal muscle arterioles.**
  - **NOS is an enzyme responsible for the production of the potent vasodilator, nitric oxide.**

Arterial Remodeling and Functional Adaptation Induced by Microgravity (PI: M. Delp)

Research/Validation

Results of hindlimb suspension studies performed in PI's laboratory:

- **The headward fluid shifts that take place in rat hindlimb suspension studies resemble the fluid shift in humans that are induced by microgravity.**
- **Significant decreases in the responsiveness of the vessels to elevations and reductions in fluid pressure.**
  - Diminished ability to constrict.
- **Diminished smooth muscle tone of feeder arterioles in the muscles of hindlimbs.**
  - Smooth muscle cells atrophy.
- **Compromised ability to elevate peripheral vascular resistance.**
  - Reduced ability to maintain normal arterial blood pressure.

Arterial Remodeling and Functional Adaptation Induced by Microgravity (PI: M. Delp)

Research/Validation

- Ground studies identified during the definition phase are complete.
  - Length of time muscle complex is viable post dissection, when placed in cold physiological solution:
    - Vessel physiological responses, gene expression and vessel morphology are viable for at least 8 hrs.
    - Constriction responses and vessel morphology remain intact after 24 hrs.
    - Vessel dilation responses and gene expression are compromised after 24 hrs.
- These results establish a reasonable time frame in which to complete the experimental objectives.
- However, dilation and gene expression objectives would likely be lost in the occurrence of a Dryden landing.

Arterial Remodeling and Functional Adaptation Induced by Microgravity (PI: M. Delp)

Science / Validation. Description

Experiment Operations Concept:

- **Specimen requirements: 8 male, sexually mature, Sprague-Dawley rats (8+ weeks old), and weighing ~ 300 grams at launch. Animals will be shared with Dr. Gabrion.**
- **Hardware requirements: 2 Flight AEMs, with 4 rats each**
  Biomass: ~ 1200 grams per AEM at launch
- **AEM caged and Vivarium ground controls will be run on 48 hr. and 96 hr. delayed basis.**
- **PI team will arrive at KSC at ~L-3 weeks for laboratory set up and equipment operation verification.**
- **PI team will participate in a Facility Trial Run at KSC at ~L-2 weeks and will perform several wet runs prior to launch and during flight.**

Arterial Remodeling and Functional Adaptation Induced by Microgravity (PI: M. Delp)

Science / Validation, Description

Experiment Operations Concept:

Post-Flight Processing

- **Following anesthesia and euthanasia, the soleus-plantaris-gastrocnemius muscle complex will be removed (at 15 minute intervals) and stored at 4˚C until vessel microdissections can take place.**
- **Vessels will be microdissected and isolated arterioles will be analyzed at KSC for alterations in physiology.**
- **During the collection of physiological data, additional vessels will be removed from the muscles, frozen and shipped at -70°C to PI laboratory for subsequent morphology and gene expression studies.**

Arterial Remodeling and Functional Adaptation Induced by Microgravity (PI: M. Delp)

Science / Validation, Description

- **Minimum Mission Requirements:**

  Ground studies indicate that hindlimb suspension produces significant alterations in vascular function after 7 days. Thus, shuttle missions of 7 days or more should produce measurable vascular changes. PI will analyze vessels from missions of 4 days or more to determine if vascular changes are evident in animals exposed to microgravity for 4 days.

- **Contingency Landing Requirements**

  In the event of a Dryden landing muscle complexes, with arterioles, will be dissected and placed in 4°C physiological solution for transport (at 4°C) to KSC as soon as possible for microdissection and analysis. Dilation and gene expression objectives will be lost after 24 hours.

Anatomical Studies of Central Vestibular Adaptation: Neurolab Completion Proposal (93-OLMSA-01-127)

Principal Investigator: Gay R. Holstein Ph. D.
Mount Sinai School of Medicine

Astronauts experience vestibular abnormalities during adaptation to microgravity and again during re-adaptation to Earth's gravity. Vestibular abnormalities may include:

- **Postural illusions, sensations of rotation.**
- **Nystagmus (involuntary motion of the eye).**
- **Dizziness and vertigo (sense of whirling about, disorientation).**
- **Space adaptation sickness.**

Results from this experiment will:

- **Help identify the the cellular basis underlying the adaptation processes.**
- **Provide insights for the development of effective pharmacological therapeutic countermeasures.**

Anatomical Studies of Central Vestibular Adaptation: Neurolab Completion Proposal (PI: G. Holstein)

- **Experiment Objectives:**

- **Identify the morphologic alterations in rat cerebellar cortex that correlate with re-adaptation to 1 g following adaptation to the microgravity environment. Specific aims are to:**

  - **Compare the nature and extent of the ultrastructural evidence for neuronal degeneration and synaptic plasticity present in vestibular and non-vestibular regions of the rat cerebellar cortex.**

  - **Determine if the alterations are pathway and neurotransmitter specific.**

Anatomical Studies of Central Vestibular Adaptation: Neurolab Completion Proposal (PI: G. Holstein)

Hypothesis

- **Alterations in ultrastructural features accompany adaptation to microgravity and readaptation to 1 g.**

- **Alterations are pathway and neurotransmitter-specific.**

Anatomical Studies of Central Vestibular Adaptation: Neurolab Completion Proposal (PI: G. Holstein)

Research/Validation

- No additional ground studies are required in development of this experiment for flight.
- Results from STS-90 indicate that ultrastructural reorganization occurs in gravity-recipient zones of the cerebellum following exposure to the microgravity environment.
  - Marked neuronal degeneration and synapse retraction.
  - Unexpected findings that bear important consequences for future space missions.
- Focus of the STS-107 E-127 experiment is to
  - Confirm the ultrastructural reorganization in perfusion fixed brain tissues.
    - Perfusion is the optimal fixation method for ultrastructural tissue preservation.
    - Immersion fixative method (not optimal for ultrastructural analyses) was used in the Neurolab experiment due to multi-experiment sharing and flight constraints.
  - Evaluate the differences in excitatory and inhibitory amino acid neurotransmission in the vestibular cerebellum of perfusion fixed flight and control rats.

Anatomical Studies of Central Vestibular Adaptation: Neurolab Completion Proposal (PI: G. Holstein)

Science / Validation Description

Experiment Operations Concept:

- **Specimen requirements: A minimum of 5 male Fischer 344 rats of sexual maturity at launch (10+ weeks old), and weighing at ~ 240 grams at launch.**

  - 5 animals will provide adequate *n* for statistical analysis.

- **Hardware requirements: 1 AEM, with 5 rats,**

  Total of ~1200 grams biomass at launch.

- **AEM caged ground control will be run on a 48 hr. delayed basis.**
- **PI will arrive at KSC at ~ L - 1 week for laboratory set up and verification of equipment and post flight experiment processing at KSC.**
- **Post flight dissections and tissue processing will occur on R+1 day.**

Anatomical Studies of Central Vestibular Adaptation: Neurolab Completion Proposal (PI: G. Holstein)

Science / Validation Description

Experiment Operations Concept:

Post-Flight Processing

- **Animals will be placed in Vivarium cages for re-adaptation to gravity until R+1 day.**
- **Animals will be euthanized by transcardiac perfusion on R+1day.**
- **After perfusion, brains will be dissected and placed in individual vials containing cold 4% paraformaldehyde in phosphate-buffered saline, maintained and shipped at 4°C for overnight delivery to the PI laboratory.**
- **Tissue processing for electron microscopy and post embedding immunocytochemistry analyses will occur in the PI laboratory.**

Anatomical Studies of Central Vestibular Adaptation: Neurolab Completion Proposal (PI: G. Holstein)

Science / Validation Description

- **Minimum Mission Requirements:**

  Significant science return is expected after a minimum flight of 24 hrs. PI will process specimens from missions of 24 hrs. or more.

- **Contingency Landing Requirements:**

  In the event of a Dryden landing, PI team members will fly to Dryden at the announcement of the de-orbit burn. On R+1 day the team will perform perfusions and dissections. Tissues will be maintained at 4°C and shipped to the PI laboratory. Team will return to KSC to process ground controls.

Choroidal Regulations Involved in the Cerebral Fluid Response to Altered Gravity: Water Transports and Serotonergic Receptors (98-HEDS-02-409)

Principal Investigator: Jacqueline Gabrion, Ph.D.

Université Pierre & Marie Curie-Paris VI

Spaceflight induces a cephalic (headward) fluid shift and adaptation to microgravity involves regulation of fluid compartments.

Previous spaceflight experiments with rats suggest that choroidal Cerebral Spinal Fluid (CSF) production is reduced in rats exposed to microgravity.

A reduction in CSF may contribute to the headaches, nasal stuffiness and a sense of fullness of the head which are frequently endured by astronauts during adaptation to spaceflight.

This experiment will lead to fundamental information about the mechanisms associated with cerebral homeostasis and fluid balance.

Choroidal Regulations Involved in the Cerebral Fluid Response to Altered Gravity: Water Transports and Serotonergic Receptors (PI: J. Gabrion)

Experiment Objectives

- To evaluate the effects of spaceflight on
  - Water and ion transport in the brain, hypophysis, kidneys, and lungs.
  - Serotonergic regulation and nitric oxide expression in the choroid plexus.

Hypothesis

- Is the biosynthesis of proteins involved in water (aquaporin) and ion transport impaired in the brain, hypophysis, kidney and lungs?
- What is (are) the regulatory pathway(s) responsible for increased cGMP (guanosine cylic monophosphate) levels previously measured in the choroid plexus of spaceflown rats: serotonin or nitric oxide?

Choroidal Regulations Involved in the Cerebral Fluid Response to Altered Gravity: Water Transports and Serotonergic Receptors (PI: J. Gabrion)

Research Validation

- **No additional ground studies are required in development of this experiment for flight.**
- **Results of previous spaceflight experiments suggest that choroidal CSF could be reduced during adaptation to spaceflight.**
- **Results from ground rat hindlimb suspension studies show similar responses.**
- **PI is continuing ground based head down suspension studies and hypergravity studies to investigate expression of the proteins involved in water (aquaporins) and ion (NaK dependent ATPase) transport.**

Choroidal Regulations Involved in the Cerebral Fluid Response to Altered Gravity: Water Transports and Serotonergic Receptors (PI: J. Gabrion)

Science / Validation, Description

Experiment Operations Concept:

- **Specimen requirements: A minimum of 8 male Sprague-Dawley weighing ~ 300 grams at launch. Animals will be shared with Dr. Delp.**
- **Hardware requirements: 2 Flight AEMs, with 4 rats each**

  Biomass: ~ 1200 grams per AEM at launch
- **AEM caged and Vivarium controls will be run on a 48 hr. and 96 hr. delayed basis**
- **PI team will arrive at KSC for laboratory set-up at ~L-2 weeks.**
- **PI team will participate in the Facility Trial Run with Dr. Delp's team to verify proper equipment function and dissection flow.**

Choroidal Regulations Involved in the Cerebral Fluid Response to Altered Gravity: Water Transports and Serotonergic Receptors (PI: J. Gabrion)

Science / Validation, Description

Experiment Operations Concept:

Post-Flight Processing

- **Following anesthesia and euthanasia, the brain, hypophysis, kidneys and lungs will be removed and either placed in fixative, frozen or embedded, prior to shipment to PI's laboratory.**
- **Ultrastructural, immunocytochemistry, and *in situ* hybridization analyses will be performed at the PI's laboratory.**

Choroidal Regulations Involved in the Cerebral Fluid Response to Altered Gravity: Water Transports and Serotonergic Receptors (PI: J. Gabrion)

Science / Validation, Description

- **Minimum Mission Requirements:**

  Little is known about the effect of microgravity on the expression of proteins involved in water and ion transport. Significant science return is expected after a mission duration of 24 hrs.

- **Contingency Landing Requirements:**

  In the event of a Dryden landing, the PI will have a team available to dissect the tissues and freeze them or place in proper fixative. The tissues will then be transported to KSC as soon as possible for continued processing prior to shipment to PI's laboratory. All science objectives can be achieved.

Fundamental Rodent Experiments Supporting Health (FRESH-02)

- **Biocompatibility Test and Experiment Verification Test (EVT) are not required for the 3 FRESH-02 Experiments due to the successful flight history of the AEM.**
  - **Previous flights (over 16 missions) with adult rats in the AEM demonstrate that the AEM provides a safe environment that maintains the health and well being of adult rats in microgravity.**
  - **PI (Dr. Holstein) is requesting SPACEHAB environmental data (vibration, temperature, etc.) to determine necessity for additional ground testing.**

Fundamental Rodent Experiments Supporting Health (FRESH-02)

FRESH-02 Pre-Flight Activities

L-6 weeks	**Sentinel animals sent from vendor to Anmed for SPF verification**
L-4 weeks	**Animal receipt**
	- Oral/fecal samples taken for microbiology analysis and SPF verification
	- Housed in Vivarium cages and placed on flight food bar diet.
	- Water bottles with modified lixits
	- 12/12 hr light cycle
	- Temperature expected in AEM in SPACEHAB during flight.
L-4 wk - L+0	**Daily health checks will be performed.**
	Food, water and body weight data will be recorded every third day.
L-1 wk	**Animals will be placed into flight groups in Vivarium cages.**
	- Acclimation to cage mates and similar cage floor space
L-2 days	**Animal selection for flight will be based on normal weight gain and daily health observations.**
L-43-31 hrs	**Animals will be loaded into the AEMs for turnover to SPACEHAB.**

Fundamental Rodent Experiments Supporting Health (FRESH-02)

FRESH-02 Scrub Turnaround Scenario

- **Animals will be loaded at launch minus 43-31 hrs. In the event of a 24 hour scrub the animals will remain on-board. Upon the announcement of a second 24 hour scrub the animals will be removed from the SPACEHAB. At that time there will be a 96 hour stand down. Another group of animals (Launch Contingency Group 1) will then be loaded at launch minus 43-31 hrs prior to the next launch attempt.**
  - **Animals will be on the pad for no longer than 72 hours.**
- **Planning includes support for launch attempts through 30 days.**

Fundamental Rodent Experiments Supporting Health (FRESH-02)

FRESH-02 In-Flight Activities

- Daily on-orbit observations and recording of animal health
- Daily hardware check
- Water refill operation every three to four days

FRESH-02 In-Flight Contingency Procedures

- In the unlikely event of an AEM hardware failure or an animal crisis the NASA Chief Veterinarian will be available, by call down, to evaluate the severity of the crisis and will determine whether euthanasia is necessary. The AEM CO_2 System (ACOS), currently under development, will provide the crew with a safe and rapid means of euthanizing the animals.

Fundamental Rodent Experiments Supporting Health (FRESH-02)

FRESH-02 Ground Activities

- Ground controls will be conducted at KSC in AEM cages
- Daily observations and recording of animal health
- Daily hardware check
- Water refill every three to four days

FRESH-02 Post-Flight Activities

- Rats will be removed from the Shuttle by R+6 hrs.
- The animals will be unloaded from the AEMs upon receipt at the receiving facility
- A health check will be performed by the NASA attending veterinarian.
- Animals will then be transferred to the investigators for post-flight processing.

Fundamental Rodent Experiments Supporting Health (FRESH-02)

FRESH-02 Contingency Landing Site Activities

- **Project team will be at Dryden Payload Receiving Facility for receipt of animals at L+24 hrs.**
- **Dr. Gabrion will have team available to support dissections for mission length of 24 hours.**
- **Dr. Holstein will have team available to support dissections for mission length of 24 hours.**
- **Dr. Delp will have team available to support dissections for mission length of 4 days.**

Fundamental Rodent Experiments Supporting Health (FRESH-02)

Summary of FRESH-02 Experiments

- **Investigating adaptations induced by microgravity and their underlying mechanisms. The experiments will provide fundamental information about mechanisms associated with:**
  - **Post - spaceflight orthostatic intolerance.**
  - **Vestibular and sensory motor adaptation to space flight and re-adaptation to Earth's gravity.**
  - **Cerebral homeostasis and fluid balance.**

- **In the event of a nominal flight we should be able to meet all the research objectives for these experiments.**
  - **PIs have plans and personnel ready to cover pre-flight, post-flight and scrub turn-around activities.**
  - **PIs have plans and personnel ready to cover contingency requirements.**

Bacterial Physiology And Virulence On Earth And In Microgravity
96-HEDS-04/05-406

Principal Investigator: Barry Pyle, Ph.D., Montana State University

In the context of human life support in spaceflight, there is a need for high quality drinking water to limit the risks of infections in human occupants and minimize water system deterioration.

The immune system suppression observed in astronauts after spending time in microgravity may lead to an increased susceptibility to infections caused by waterborne pathogens which are normally not pathogenic.

Some bacteria subject to microgravity have an increased resistance to anti-microbial agents and their growth rates are greater than those observed on earth.

Bacterial Physiology And Virulence On Earth And In Microgravity (PI: B. Pyle)

Pseudomonas aeruginosa:

- **Are among the most common pseudomonads isolated from Space Shuttle water systems.**
- **The *Pseudomonas* species is a diverse group of micororganisms that are widely distributed in the environment and are part of the normal intestinal flora of healthy humans.**
- **An opportunistic infectious microorganism that can cause disease by producing Exotoxin A, a toxin that affects the cells and physiologic function of the host.**
- **Typically causes infections in people only when they are severely immuno-compromised.**

Bacterial Physiology And Virulence On Earth And In Microgravity (PI: B. Pyle)

Experiment Objectives:

- **Determine if spaceflight and microgravity affects the growth, physiology, and virulence of *Pseudomonas aeruginosa.***

Hypothesis

- **Microgravity and/or spaceflight conditions affects the growth, physiology and virulence of *Pseudomonas aeruginosa.***
- **The specific virulence and physiological factors to be considered are Exotoxin A production, viable cell numbers, total cell numbers, membrane integrity, respiratory activity, and esterase activity.**

Bacterial Physiology And Virulence On Earth And In Microgravity (PI: B. Pyle)

Research/Validation

- **Results from PI tests have determined:**
  - **Incubation time required - 24 hours will yield better Exotoxin A production.**
  - **Silicon versus steel plungers for Phorbol - Silicon plungers will be used.**
  - **Chemo-luminescence versus ELISA assay - Determined ELISA will be used for Exotoxin A analysis.**
  - **Feasibility of Phorbol hardware – Determined *P. aeruginosa* can grow and produce Exotoxin A in Phorbol volume.**
  - **Feasibility of Plunger Box units - Plunger Box hardware will no longer be used.**
  - **Media to be used (SMDII).**
  - **Fixative to be used (Formalin, 0.24% and Sodium Azide, 3.3%)**
  - **Effects of returning cultures at ambient temperature (28°C) - Slight increase in Exotoxin A occurs on days 10-14 at 28°C. PI prefers to return all samples at 5°C.**
  - **The effects of a 24 hour launch delay and turn around timeline - Cells are inducible after an additional 48 hours at 5°C. Launch delay will not effect samples.**

Bacterial Physiology And Virulence On Earth And In Microgravity (PI: B. Pyle)

Research/Validation

Continued PI tests include:

- **Improving the post-flight sample processing assays.**
- **Resolving issues with bacteria culturability after storage at 5°C.**

  Preliminary results indicate that the new growth media has improved culturability of the bacteria. Further tests in the Phorbol hardware are currently underway.
- **Variability in bacteria growth within the Phorbol hardware has been observed.**

  The PI believes residual contamination in the hardware may cause variability.

  The ESA Phorbol hardware will be refurbished by the manufacturer which should remove any contamination.

Bacterial Physiology And Virulence On Earth And In Microgravity (PI: B. Pyle)

Science / Validation, Description

Biocompatibility Studies:

- **Biocompatibility test has determined adequate growth and production of Exotoxin A in the Phorbol cassettes.**
- **Experiment integration will be verified at the ESA Experiment Sequence Test (EST) scheduled for September 2000.**

Bacterial Physiology And Virulence On Earth And In Microgravity (PI: B. Pyle)

Science / Validation, Description

Experiment Operations Concept

- **Specimen requirements: *Pseudomonas aeruginosa* (cultured in PI laboratory).**
- **Hardware requirements: - 8 Flight Phorbol cassettes incubated in ESA Biopack facility (4 stationary & 4 on in-flight centrifuge). - 8 Phorbol cassettes incubated in ESA Ground Biopack facility (4 stationary & 4 in centrifuge).**

Bacterial Physiology And Virulence On Earth And In Microgravity (PI: B. Pyle)

Science / Validation, Description

Experiment Operations Concept

Minimum Mission Requirements

- **PI will require 24 hour incubation of samples which is currently scheduled to occur on MET Day 7.**
- **In the event of a shortened mission incubation for 24 hours on an earlier flight day will meet PI requirements.**

Contingency Landing Requirements

- **Samples are to be maintained at 5°C and sent back to KSC by ESA as soon as possible for processing at KSC by the PI team. Samples need to be received and processed by R+24 hrs. to achieve science objectives.**

Scrub Turnaround Requirements

- **Cells are inducible after an additional 48 hours at 5°C. Launch delay will not effect samples.**

Bacterial Physiology And Virulence On Earth And In Microgravity (PI: B. Pyle)

Science / Validation, Description

Experiment Operations Concept

- **Pre-flight Operations:**
  - **Bacterial cultures will be grown in PI laboratory and transported to KSC.**
  - **PI will load samples into Phorbol containers prior to hand over at ~L-18 hrs.**
- **In-flight Operations:**
  - **Specimens will be maintained at 5°C in the OSRF (Oceaneering SPACEHAB Refrigerator Freezer) from load through FD7.**
  - **FD7 Crew will activate samples and place in Biopack incubator for 24 hrs.**
  - **FD8 Crew will fix samples and place in Biopack refrigerator (5°C).**

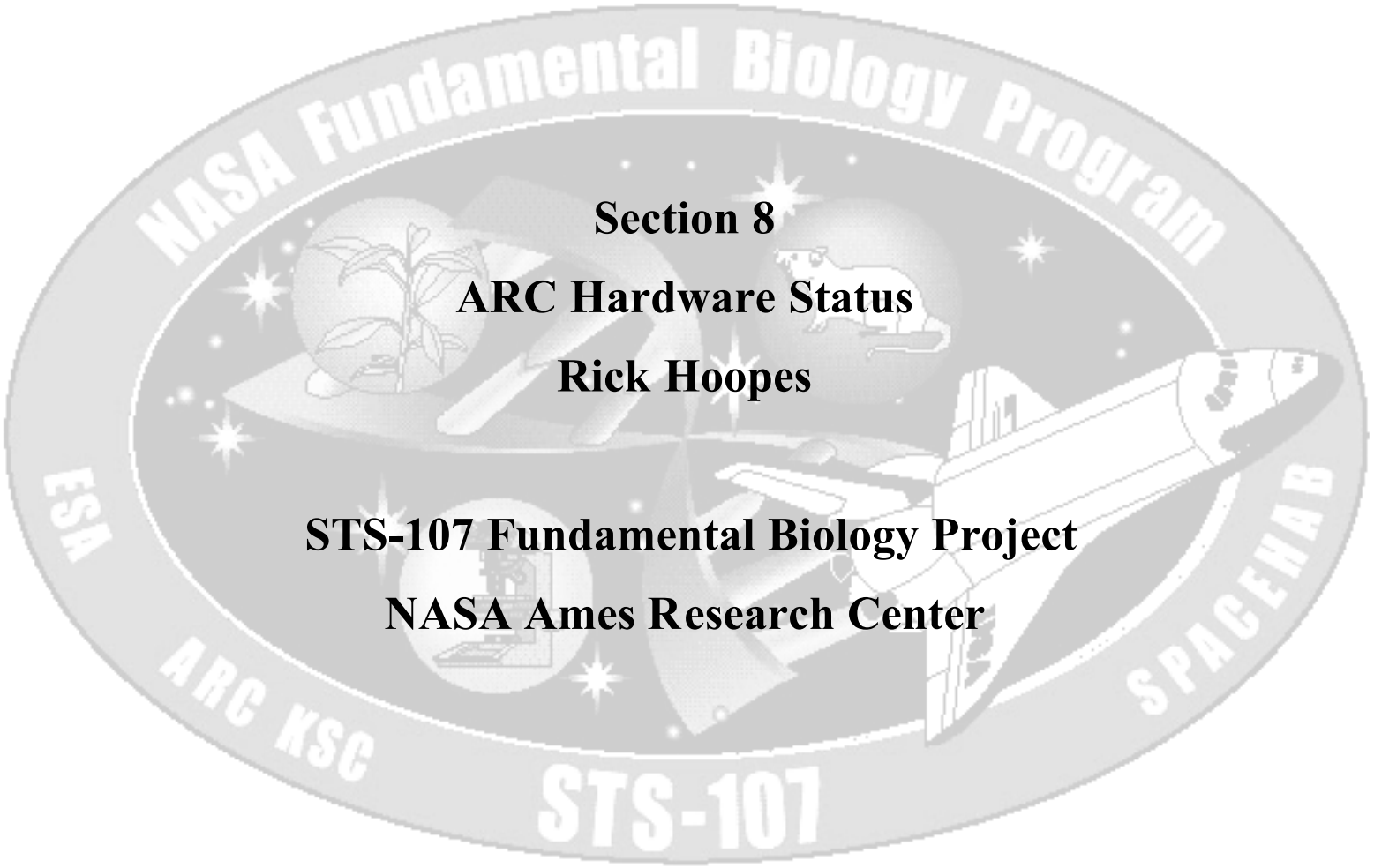
Bacterial Physiology And Virulence On Earth And In Microgravity (PI: B. Pyle)

Science / Validation, Description

Experiment Operations Concept

- **Post-flight Operations:**
  - **Processing will occur at KSC and samples will be shipped to PIs lab for further analysis.**

- **In the event of a nominal flight we should be able to meet all the research objectives for this experiment.**
  - **PI has plans and personnel ready to cover pre-flight, in-flight, post-flight and scrub turn-around activities.**
  - **PI has plans and personnel ready to cover contingency requirements.**



Section 8

ARC Hardware Status

Rick Hoopes

STS-107 Fundamental Biology Project

NASA Ames Research Center

Payload Requirements Summary

AEM

SPACEHAB Volume Required	Allocated
6 MLE	5.25 MLE

3 AEM + 3 Stowage (MLE)
Middeck Locker Equivalents

The deficit of .75 MLE is being negotiated through MMO.

Biopack

(The Biopack experiment, integration and requirements will be managed by ESA)

Hardware Item Status

AEM

- All components needed for standard AEM refurbishment and flight preparations are available.
- Foodbars and filters will be procured to support mission requirements.
- The AEM will be modified to include the AEM CO_2 System, currently at the PDR level.
- The IRU will be modified for use with the AEM and to meet STS-107 requirements.
- Planning is based on accommodating up to 30 days of launch scrubs.

Biopack

- Biopack Phorbol Cassettes will be provided and refurbished by ESA.

Hardware Item Status

AEM

- 10 Flight AEMs will be sent to KSC for use as flight and ground habitats.
- 3 AEMs will fly in the SPACEHAB.
- This inventory supports the current project scrub scenario.

Resource Summary

- **Power Profiles**
  - **The standard AEM power profiles will be used.**
- **Thermal**
  - **The previously flown AEM thermal loads will be modified to include the FRESH 02 animal thermal loads.**
- **Mass Properties**
  - **The AEM mass properties have been calculated and will be transmitted to SPACEHAB.**
  - **The stowage mass properties will be calculated when the layout has been determined.**

Hardware Support

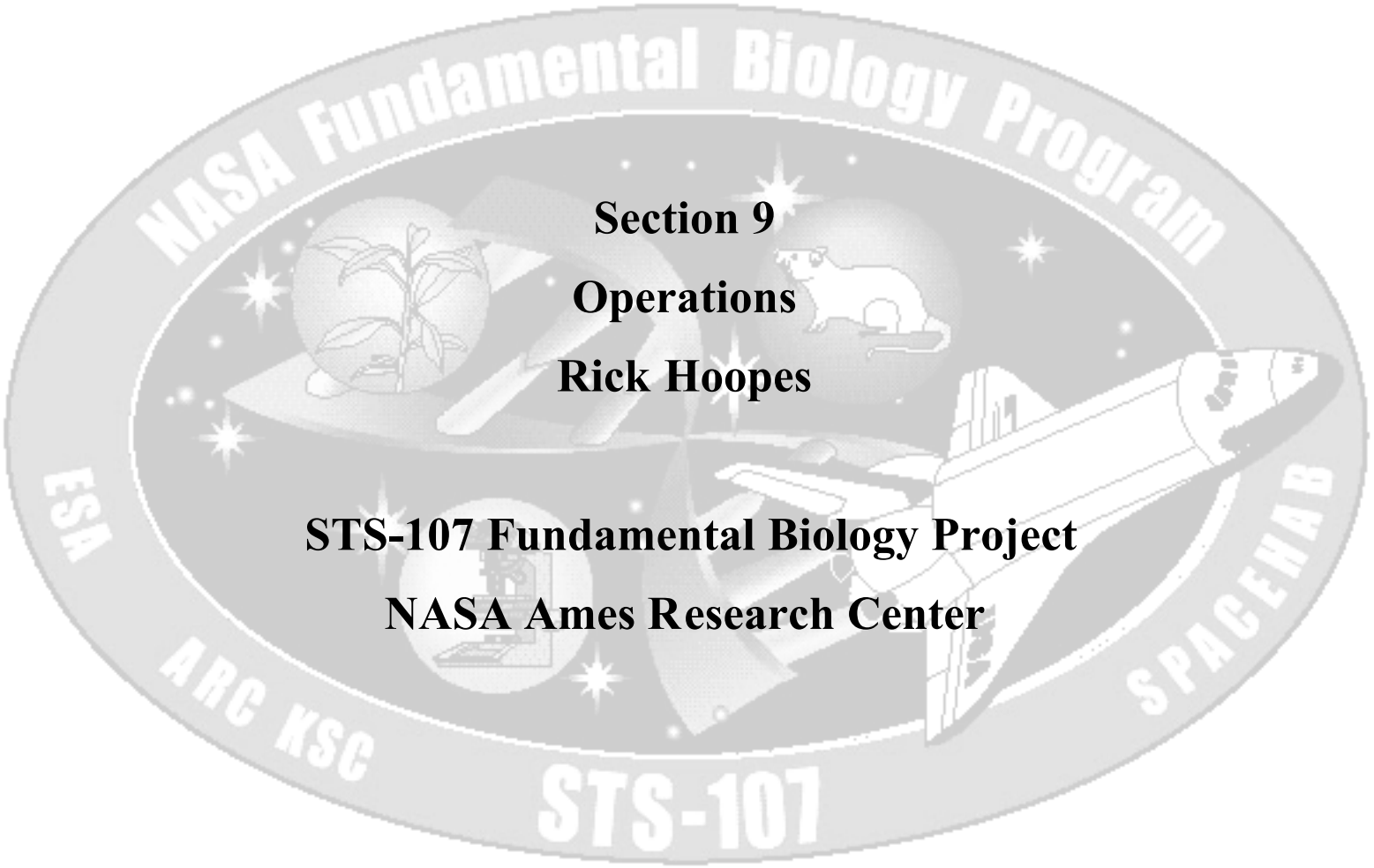
- **Flight Equipment List as provided in the initial questionnaire**

AEMs	**ARC**
Mufflers	**ARC**
IRU	**ARC**
ACOS/CO_2	**ARC**
Biopack	**ESA**

- **Ground Support Equipment List**

  The preliminary list of KSC requirements has been submitted.

  ARC supplied equipment exists, no new equipment has been identified.



Section 9

Operations

Rick Hoopes

STS-107 Fundamental Biology Project

NASA Ames Research Center

OPERATIONS

Hangar L Requirements

- All AEM operations will be performed at Hangar L.
- Preliminary Hangar L facility requirements have been submitted. (4/22/00)

Flight Operations Requirements

- Flight hardware integration into SPACEHAB will be monitored at KSC.
- During flight ARC personnel will staff the POCC at JSC and support the mission at KSC and Dryden.

Late Access Requirements

AEMs

- SPACEHAB late access window is L-43 to L-31.5 hours.
- ARC has requested to be integrated as late in the window as possible.

Biopack (ESA)

- The requirement of L-19 hours turnover has been submitted.

OPERATIONS

Early Recovery Requirements

AEMs

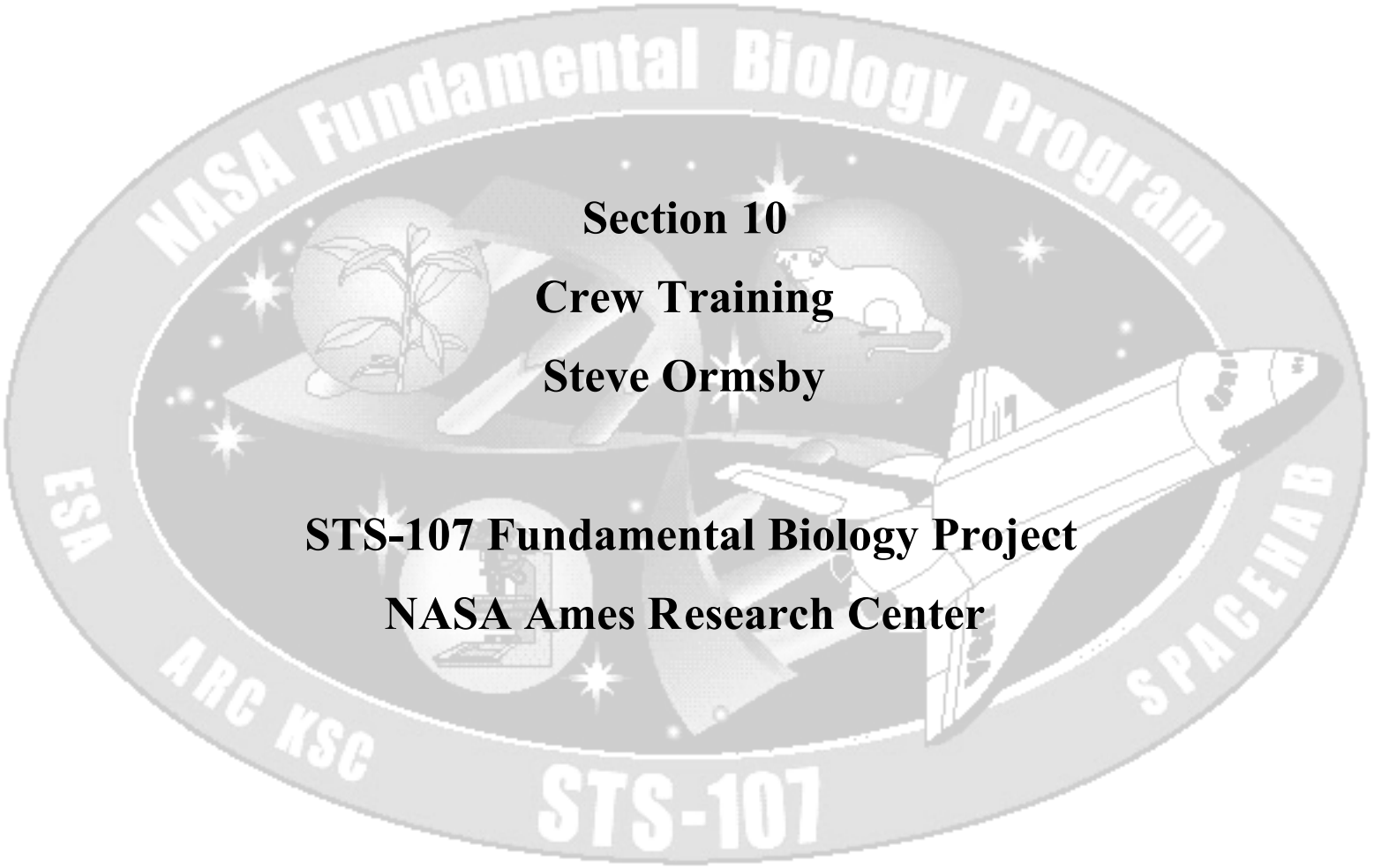
- **R+6 hrs**

Biopack (ESA)

- **R+3 hrs**

Alternate Landing Sites

KSC will be the primary landing site
Dryden will be the first alternate landing site
The PRF will be prepared for animal dissections



Section 10

Crew Training

Steve Ormsby

STS-107 Fundamental Biology Project

NASA Ames Research Center

CREW TRAINING APPROACH

- **Crew Training will support all aspects of the FRESH-02 experiment, hardware and science familiarization.**
- **ESA is responsible for crew training of the Biopack experiment.**
- **KSC is responsible for crew training MFA/Biotube and BRIC experiments.**

CREW TRAINING
Major Milestones FRESH-02

• Training Questionnaire Delivered to SPACEHAB	12/2/99
• Training Questionnaire updated, submitted to MMO	3/31/00
• Draft FOs submitted to MMO	3/31/00
• ARC Training Readiness Review (ARC requirement)	6/26/00*
• Familiarization Briefing Dry Run w/SPACEHAB at ARC	7/10/00*^
• Submit Crew Familiarization Material to SPACEHAB	7/19/00*
• Crew Training hardware pre-ship review (ARC requirement)	7/19/00*
• Crew Familiarization and Hands On Training at JSC	7/31/00*
• Refresher Training at SPPF	11/27/00*

***Based on STS-107 Preliminary Training Schedule Rev. B (Launch 2-22-01)**

^Requirement established at SPACEHAB Kick-off Meeting 1/19/00

CREW TRAINING
Major Milestones FRESH-02 (con't)

- **Nominal / Malfunction Procedures**
  - **Draft** **5/12/00***
  - **Project Review** **5/19/00***
  - **Incorporate Redlines** **5/26/00***
  - **Submit Preliminary to SPACEHAB** **5/30/00***
  - **Submit to SPACEHAB for Basic Release** **6/13/00***
  - **Validate (training hardware available)** **8/1/00***
  - **Submit to SPACEHAB for Final Release (L-1 month)** **1/22/01***

***Based on STS-107 Preliminary Training Schedule Rev. B (Launch 2-22-01)**

CREW TRAINING CURRICULUM FOR FLIGHT CREW

- **FRESH-02**
  - **Science Familiarization Training** **1.0 hr**
  - **Animal Health Observations** **1.0 hr**
  - **AEM Hardware Familiarization** **0.3 hr**
  - **AEM CO_2 System Familiarization** **0.3 hr**
  - **IRU Hardware Familiarization** **0.3 hr**
  - **Nominal Operations Training** **1.5 hr**
  - **Malfunction Training** **1.5 hr**

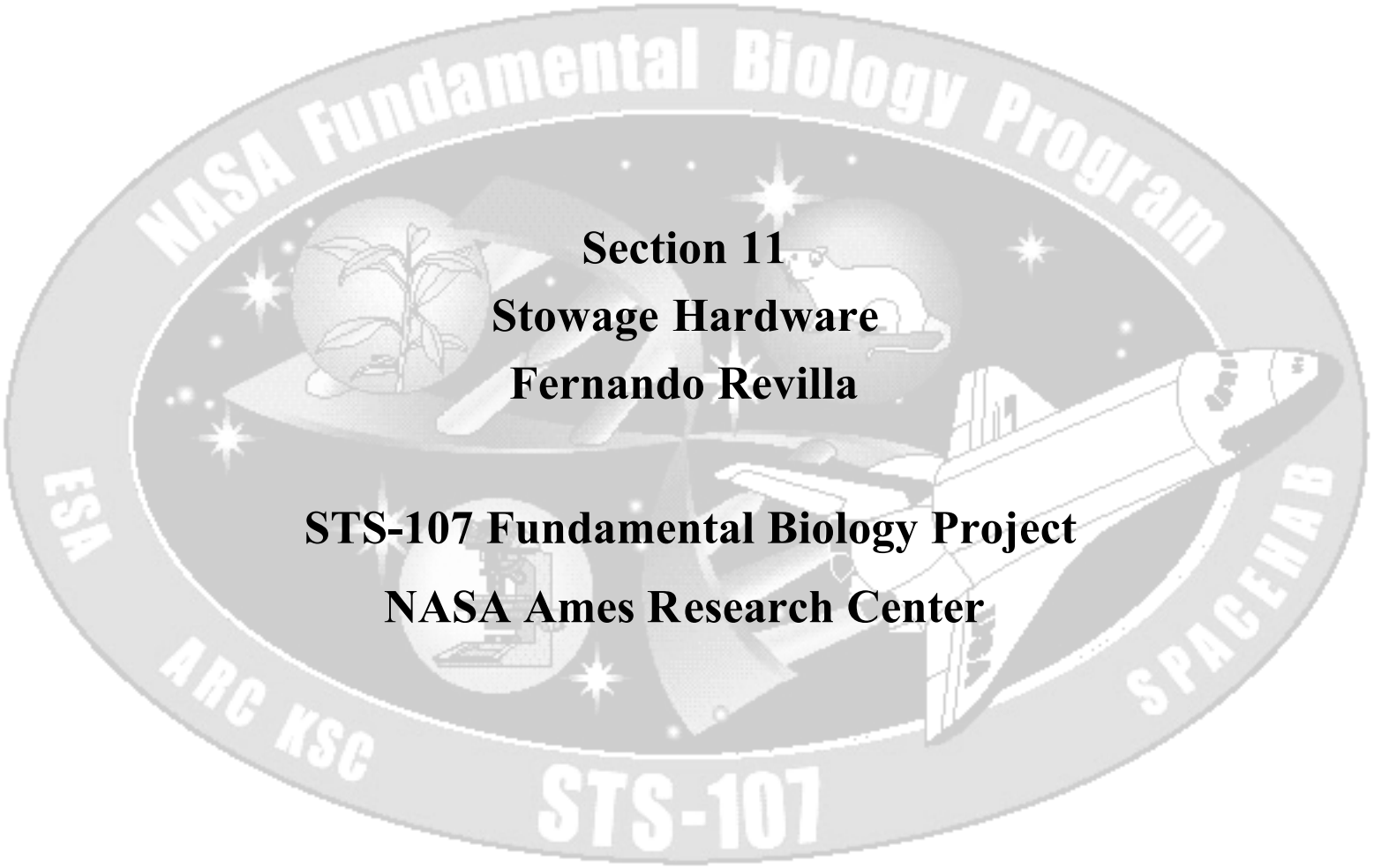
*** As submitted to SPACEHAB in Experiment Training Requirements Questionnaire**

CREW TRAINING

- **IN-FLIGHT NOMINAL OPERATIONS FOR FRESH-02**
  - **AEM Hardware check**
  - **Animal health observations**
  - **AEM water refill using IRU**

CREW TRAINING HARDWARE

	QUANTITY
• AEM Training Unit	1
• AEM Muffler	1
• AEM CO_2 System (ACOS)	1
• IRU Training Unit	1
• IRU Accessories	1
• SORG mockup	1
• SPACEHAB Modified Locker (SPACEHAB Provided)	1



Section 11
Stowage Hardware

Fernando Revilla

STS-107 Fundamental Biology Project

NASA Ames Research Center

STOWAGE LIST SUMMARY

STOWAGE ITEM	FLT. QTY.	HAREWARE STATUS
Inflight Refill Unit, IRU	1	Series Reflown - Pump Unit, Water Reservoir & Cover
IRU Accessories		
Inlet Hose	1	Reflown
Outlet Hose	1	Series Reflown
Manual Adapter	1	Series Reflown
Powered Adapter	1	Series Reflown
Power Cable	1	New Design
Tether	1	Series Reflown
Fluid Pumping Unit, FPU	1	Series Reflown- Spare Pump Unit
$C0_2$ Storage Assembly	3	New Design - Cylinder Assy. in Pouch
$C0_2$ Umbilical Assembly	1	New Design - Hose Assy.
Muffler Assembly, AEM	3	Reflown
LiOH Canisters	*2*	*(ARC stowage provided by Orbiter)*

ARC proposed SPACEHAB Locker Configuration

Stowage Locker # 1

- Inflight Refill Unit (IRU)
- IRU Accessories (6 ziplock bagged items)

Stowage Locker # 2

- LiOH canister
- LiOH canister
- AEM Muffler
- AEM Muffler
- AEM Muffler

Stowage Locker # 3

- Fluid Pumping Unit(FPU)
- CO2 Storage Assy.
- CO2 Storage Assy.
- CO2 Storage Assy.
- CO2 Umbilical Assy.

HARDWARE INTERFACES:

- Tethering of IRU System in SPACEHAB
- Tethering of IRU System in Shuttle Middeck
- IRU Inlet hose QD to SORG (galley) Water Outlet
- IRU Power Cable to SPACEHAB 28V Power Outlet
- Mounting of $C0_2$ Storage Assembly in SPACEHAB

Section 12

ARC Verification Plan

Selim Ibrahim

STS-107 Fundamental Biology Project

NASA Ames Research Center

ARC Verification Plan

Ames Research Center

- **Verification activities to be performed per AV-04432 STS-107 Fundamental Biology Project Verification Plan**
- **Each deliverable end item and/or kit assembly will be verified**
- **Verification to be performed against the**
  - **As-Built Hardware Drawings**
  - **Interface Documents**
  - **Safety Requirements**
- **Use existing verification data as much as possible on series and reflown hardware**
- **Modified hardware to be verified per applicable requirements**
- **Preliminary matrix being developed for each as-built drawings per SPACEHAB Interface Definition Document Rev. J and Middeck Interface Definition Document, Rev B**

Applicable Documents

- **JA 276, Rev B**
  Payload Mission Manager Interface and Safety Verification Requirements for Instruments, Facilities, MPE, and ECE on Space Transportation System (STS) Orbiter Middeck Payload Missions

- **MDC91W5023J**
  SPACEHAB Experiment Interface Definition Document

- **NSTS 1700.7B**
  Safety Policy and Requirements for Payloads Using the Space Transportation System

ARC Verification Plan

- **AV-04432 Fundamental Biology Project STS-107 Verification Plan will be released on 6/30/00**
- **Verification Closure Reports (VCRs) will be generated based on hardware/kit release dates**
- **ESA responsible for all verification activities for the Biopack hardware**

Ames Research Center

Section 13
System Safety & Mission Assurance

Keith Jaquillard, HEI
Ken Zander, QS

STS-107 Fundamental Biology Project
NASA Ames Research Center

Objectives of the SS&MA Activity

1. **Ensure the Ames hardware/software and related procedures meet the applicable SS&MA requirements to support flight certification**

2. **Provide SS&MA support to ESA for Phorbol Science at Principal Investigator labs and at phased safety reviews as requested**

3. **Provide support to SPACEHAB SS&MA in phased safety reviews**

Applicable Requirements

NSTS 1700.7B	**Safety Policy and Requirements for Payloads Using the Space Transportation System**
NSTS 13830C	**Payload Safety Review and Data Submittal Requirements**
NSTS/ISS 18798	**Interpretation of NSTS/ISS Payload Safety Requirements**
KHB 1700.7C	**Safety Policy and Requirements for Payloads Using the Space Transportation System**
NASA-STD-3000B	**Man-Systems Integration Standards**
MDC 91W5023H	**SPACEHAB Experiment Interface Definition Document**
LLIS	**NASA Lessons Learned Information System (http://llis.gsfc.nasa.gov/)**
JA-276B	**Payload Mission Manager Interface Safety Verification Requirements for Instrument, Facilities, MPE & ECE on STS Orbiter Middeck Payload Missions**
ISO 53.QS.0008	**SS & MA Support to Projects**
QS-TR-2020	**STS-107 Risk Management Plan (draft)**
QS-TR-2021	**STS-107 SS & MA Plan (draft)**

Safety Strategy & Status: ESA Phorbol Science

- **Safety Reviews**
  - **ESA serves as safety integrator; ARC provides safety "chapters"**
  - **ESA coordinates with SPACEHAB**
  - **No current request for ARC support**

- **Phase II Flight Safety Data Chapter completed (2/00)**
  - **4 unique hazards identified**
    - **Catastrophic Release of toxic chemicals (formaldehyde)**
    - **Critical Release of toxic chemicals**
    - **Critical Release of biologicals (*Pseudomonas*)**
    - **Critical Release of non-toxic fluids (water, media)**

- **Phase II Ground chemical safety data provided, as requested (3/00)**
- **Phase III - no input requested to date**

Safety Strategy & Status: FRESH-02

Data Package Development

Must align with SPACEHAB Integrated Delta Phase II Flight Safety Review (June TBD) - originally planned an interim Ames-only review

Flight

- **Phase II Flight Safety Data Package completed 3/00**
  - **Safety critical design, data, test & analysis requirements identified**
  - **Project to conduct a splinter prior to the Safety Review**
    - **Provide updated tests/analyses/verification closure**
    - **Some hazards may be at Phase I maturity**
- **Phase III Flight**
  - **Quick turn-around following Phase II review (< 1 week)**
  - **Work on Phase III in progress**

Ground

- **Phase II Ground Safety Data Package completed 4/00**
  - **Safety & ground processing - independent of SPACEHAB**
- **Phase III Ground Safety Data Package - due 7/00**

Safety Strategy & Status: FRESH-02, con't

Animal Enclosure Module - Treated as Series/Reflown with Modifications

- **AEM Unit - Series Hardware**
  - **No new/revised hazards identified**

- **Muffler - Reflown Hardware (no modifications)**
  - **No new/revised hazards identified**

- **CO_2 Manifold Assembly - New Addition**
  - **No structural impact to AEM identified**
  - **No new hazards confirmed (asphyxiation & overpressure being evaluated)**

- **CO_2 Storage &Umbilical Assembly - New Addition**
  - **3 unique hazards identified**
    - **Catastrophic High Pressure ~ 852 psig cylinder**
    - **Critical Low Touch Temperature (< 4° C / 39° F bare handed)**
    - **Critical Unrestrained Objects (cylinder mated to AEM)**

Safety Strategy & Status: FRESH-02, cont'd

Inflight Refill Unit - Series/Modified Hardware

- **Includes accessories - will be modified**
- **No new/revised hazards identified to date**

Additional Safety / Human Factors Considerations (NASA-STD-3000B)

AEM, CO_2 & IRU

- Quick Disconnect
  - Grip size & strength for the 5th percentile female to 95th percentile male
  - Mating
    - Positive indication of QD mating
      - Visual
      - Tactile (e.g., knurled surface)
    - Sharp edges, pinch points
- Pressure Orifice
    - Positive on/off indication (position, labeling)
    - Handle protection from inadvertent actuation & kick-off loads
    - Force/restriction for the 5th percentile female to 95th percentile male
- Packaging & Handling configuration of the CO_2 stowage
    - Designed for single crew transfer - one handed goal
    - Handle or grip

Safety Concerns

- **Potential CO_2 asphyxiant risk in SPACEHAB**
  - **Asphyxiant hazard being evaluated**
  - **STS scrubbers thought to be adequate, pending SPACEHAB direction**
- **Unknown effects of CO_2 on seals & limited life items within AEM (being evaluated)**
- **Rapid safing / penetration from unstowed hardware (IRU & ACOS) (being evaluated against safety interpretation letter MA2-96-190)**

Verification

FRESH-02

- Safety verification requirements have been provided to engineering via hazard reports
- Unique hazard data will be flowed into the verification plan
- (via unique Verification Requirement Data Sheets)

ESA/Phorbol

- ESA is responsible for the verification plan
- Safety verifications identified on hazard reports

Quality Assurance

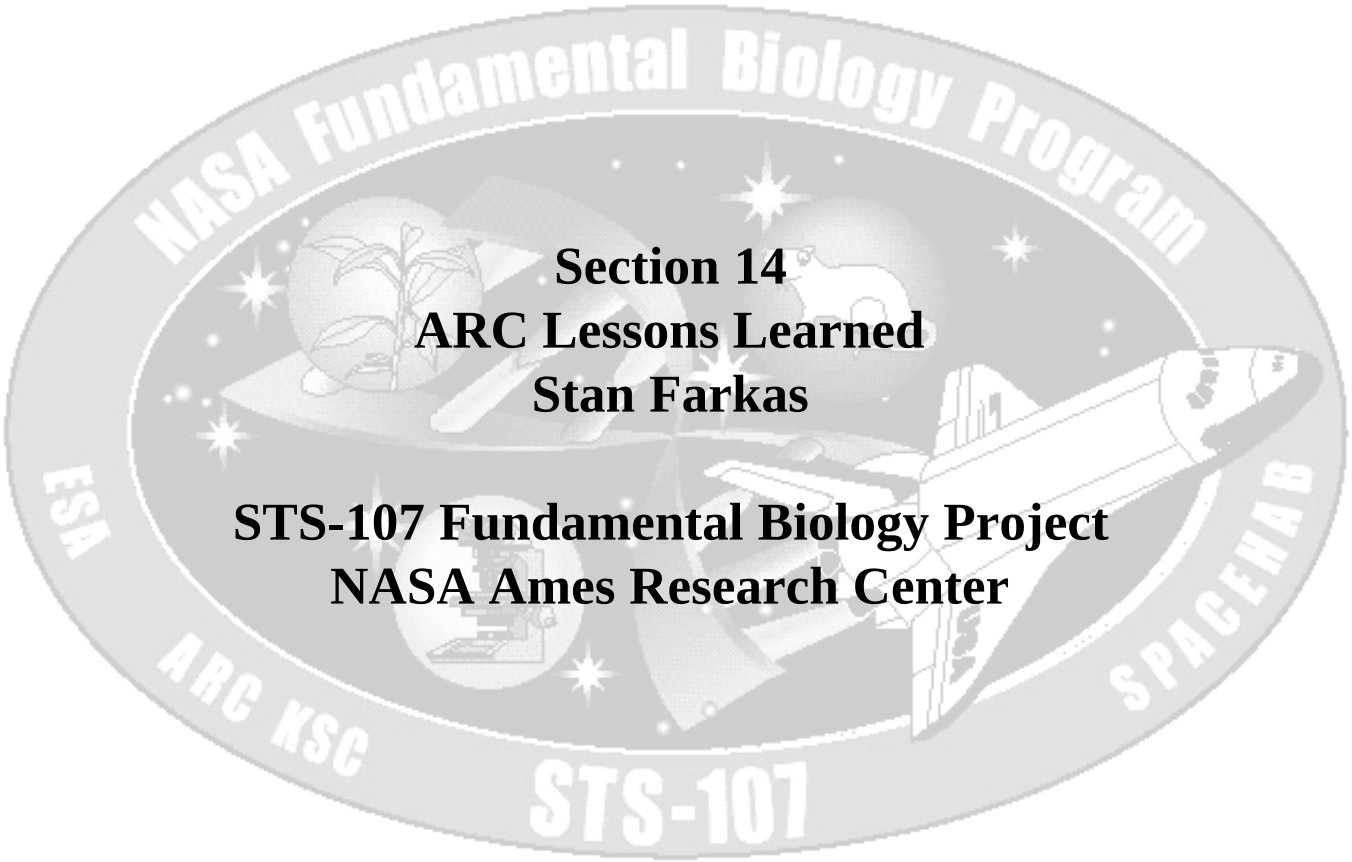
Quality Assurance function will be performed in accordance with the STS-107 SS&MA Plan

ISO Work Instruction - 53.QS.0008, *SS&MA Support to Projects*, includes:

- **Chair Material Review Board**
- **Identify inspection points**
- **Review drawings**
- **Support design reviews**
- **Approve final as-built hardware**
- **Verify all Non-Conformance Reports (NCR) are closed before flight**

Quality Assurance will support the following safety tests:

- **AEM - CO_2 thermal test; CO_2 discharge & pressure test**
- **IRU, standard reverification anticipated**
- **ESA Phorbol, e.g., leak test**



Section 14
ARC Lessons Learned
Stan Farkas

STS-107 Fundamental Biology Project
NASA Ames Research Center

ARC Lessons Learned

Ames Research Center

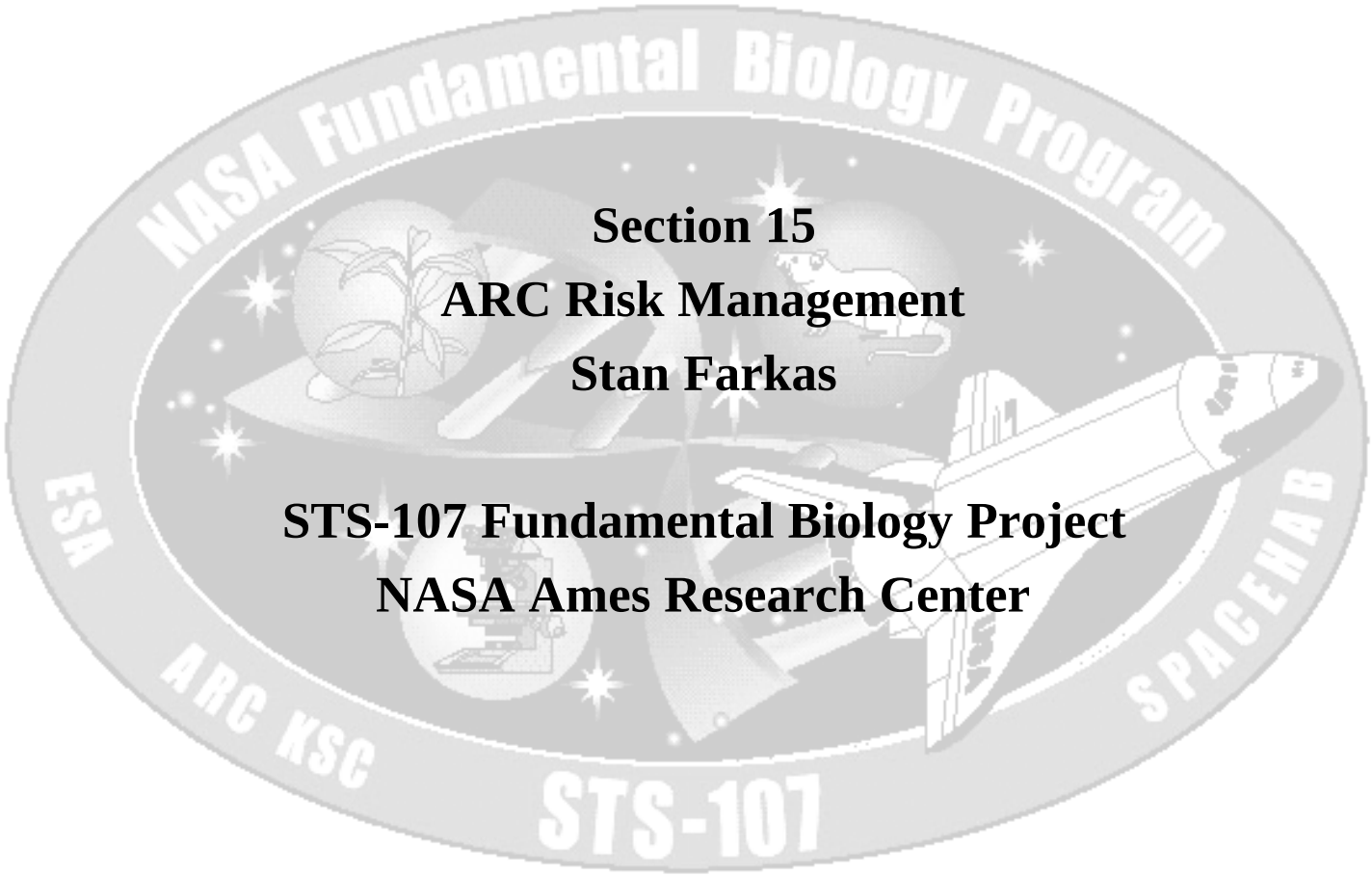
- **Approach**
  - **Database developed to catalogue lessons learned from:**
    - **Neurolab**
    - **STS-95**
    - **NIH.R4**
    - **Recent reviews and recommendations**
  - **Lessons will be reviewed and catalogued by impact area, appropriateness to STS-107 Project and recommended actions.**
  - **The database will be updated and actions to be implemented will be tracked.**
  - **Lessons from STS-107 will be added to the database and the file will be made available to future project teams.**

ARC Lessons Learned

Ames Research Center

- **Major findings**
  - **At this time the Lessons Learned electronic database is still under review by the team.**

- **Implementation of Findings**
  - **Once actions are identified the responsible discipline will provide regular status to Project Management until the action has been closed.**



Section 15
ARC Risk Management
Stan Farkas

STS-107 Fundamental Biology Project
NASA Ames Research Center

ARC Risk Management

Ames Research Center

- **Risks include Schedule, Cost, Technical, and Safety**
- **The Risk management process is defined in the STS-107 Fundamental Biology Project Risk Management Plan**
  - **Risks will be identified for all areas of the project.**
  - **Risks will be analyzed for probability of occurrence and severity/impact on the project. Related risks will be grouped, and prioritized.**
  - **A plan of action and schedule will be developed for mitigating or resolving each risk.**
  - **Each risk will be tracked and reviewed periodically to determine if the risk has been resolved, eliminated, or controlled.**

- **Methodology**
  - **Risk severity and probability attribute definitions (STS-107)**
    - **Severity**
      - **I- Catastrophic**
        - **Schedule: Major slip in milestone schedule**
        - **Cost: ≥ 25% increase to project cost; > 25% budget cut**
        - **Technical: Unable to achieve all project requirements and/or some loss of project scope or goals.**
        - **Safety: Loss of life and/or disabling injury**
      - **II - Critical**
        - **Schedule: Moderate slip in milestone schedule**
        - **Cost: 10% ≥ increase to project cost < 25%; 10% > budget cut < 25%**
        - **Technical: Unable to achieve most project requirements and/or loss of most project scope and goals**
        - **Safety: Severe but recoverable injury**
      - **III - Negligible**
        - **Schedule: Insignificant slip in milestone schedule**
        - **Cost:< 10% increase to project cost**
        - **Technical: No or minor loss of project requirements and/or no loss to project scope or goals**
        - **Safety: No injury**

- **Methodology (Continued)**
  - **Probability of Occurrence**
    - **A-Probable Highly likely to happen**
    - **B-Infrequent Could happen**
    - **C-Remote Highly unlikely to happen**

- **Methodology (Continued)**
  - **RISK ASSESSMENT MATRIX**

Probability	Severity I	Severity II	Severity III
A	H	H	M
B	H	M	L
C	M	L	L

H - High Risk **M - Medium Risk** **L - Low Risk**

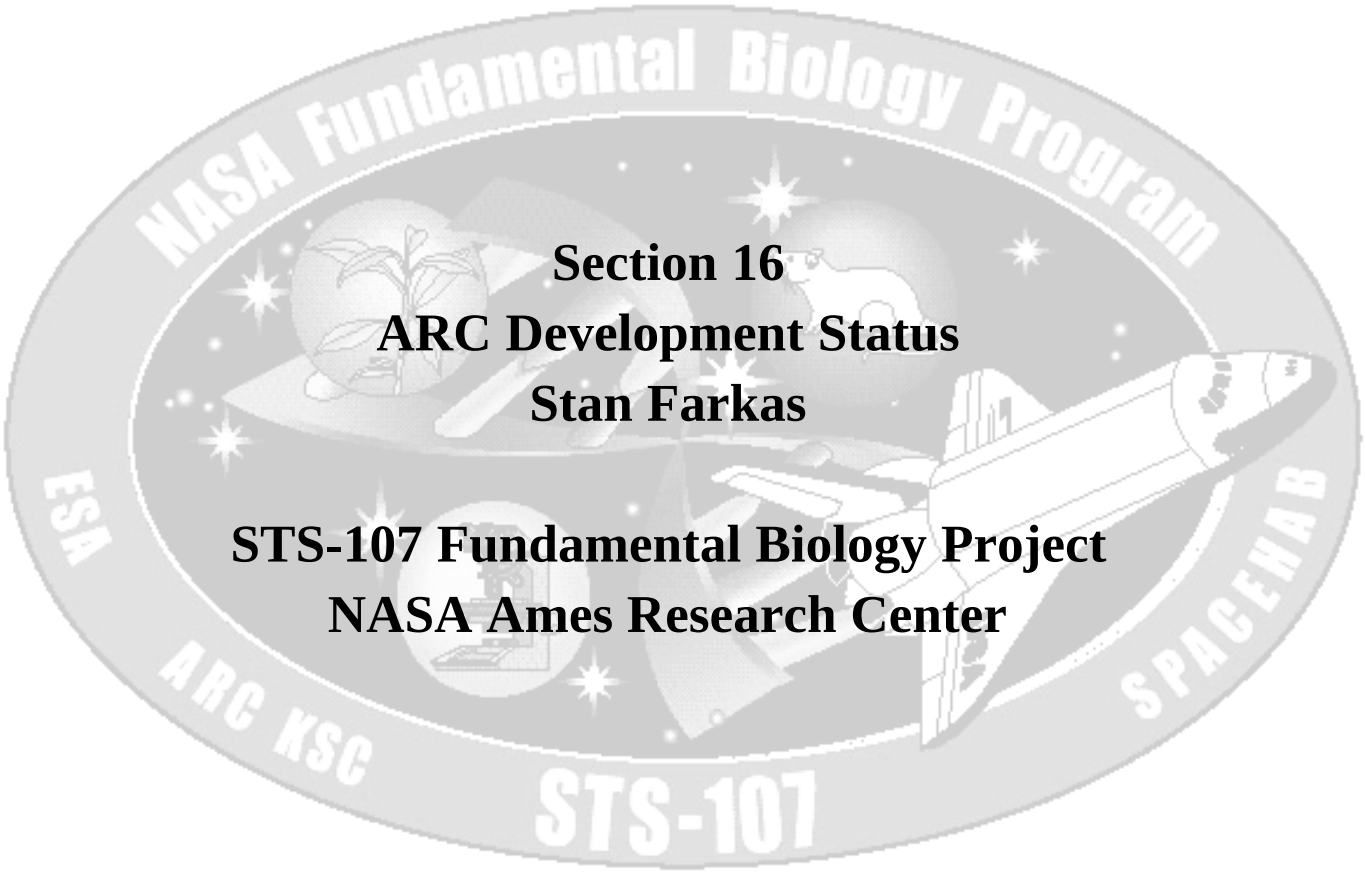
A - Probable **B- Infrequent** **C - Remote**

I - Catastrophic **II - Critical** **III - Negligible**

ARC Risk Management

Ames Research Center

- **Risk Management Results**
  - **The STS-107 Fundamental Biology Project Risk Management Plan has been baselined**
  - **Risk assessment has been started**
    - **Several high and medium risk items have been identified in the areas of project management, science, operations, and crew training**
    - **We are in the process of analyzing these risks and defining the approach for resolution.**
    - **Some mitigation has been implemented**



Section 16
ARC Development Status
Stan Farkas

STS-107 Fundamental Biology Project
NASA Ames Research Center

ARC Development Status

Ames Research Center

- **Schedule**
  - **All SPACEHAB milestones and deliverable dates have been met based on STS-107 Schedule dated 4-21-00 and STS-107 Preliminary Training Schedule Rev. B (Launch 2-22-01)**
  - **Uncertain of several tasks on STS-107 schedules.**
    - **Information in the updated training questionnaire submitted to MMO is not reflected in the STS-107 Preliminary Training Schedule Rev. B**
    - **The requirement for training dry-runs is not reflected in the STS-107 Preliminary Training Schedule Rev. B**
  - **The Inflight Refill Unit and CO2 system training hardware will not be available to support Hands-on Training per STS-107 Preliminary Training Schedule Rev. B (Launch 2-22-01)**

- **Schedule (Continued)**
  - **Some internal project planning documents were finished late or are currently under development.**
    - **Due to:**
      - **Addition of Euthanasia requirements**
      - **Change of location from Middeck to SPACEHAB**
      - **Change of PI complement**
    - **Requires addition of hardware to support changes**
      - **CO_2 system**
      - **Inflight Refill Unit and contingency back-up unit**
    - **Impacts**
      - **Hardware Development**
      - **Operations**
      - **Engineering/Stowage**

ARC Development Status

Ames Research Center

- **Budget**
  - **Budget submitted for Program Operating Plan 2000. SL approval to proceed for planning purposes until finalized**
  - **Currently working to stay within FY 2000 and FY 2001 Guidelines**

- **Deliverables - Documents baselined and delivered**
  - **Phase II Flight Safety Data Chapter (ESA Biopack)**
  - **Section II of ESA Pyle ADP**
  - **Phase II Flight Safety Data Package (AEMs)**
  - **Phase II Ground Safety Data Package (AEMs)**
  - **Experiment Requirements Document (Delp)**
  - **Experiment Requirements Document (Holstein)**
  - **Experiment Requirements Document (Gabrion)**
  - **Experiment Requirements Document (Pyle)**

ARC Development Status

Ames Research Center

- **Project Requirements**
  - **Project Management Requirements**
    - **Sufficient resources (funds and personnel) shall be provided to maximize probability of mission success:**
      - **Status: Sufficient funds and personnel available for FY2000**
    - **Project planning shall be conducted to maximize probability of mission success.**
      - **Status: Completed Project Schedules, Risk Management Plan; remaining products in progress**

- **Project Requirements (Continued)**
  - **Science Requirements**
    - **Experiment designs shall be defined**
      - **Status: Complete - Experiment Requirements Document baselined**
    - **Experiment design shall be approved**
      - **Status: ARC Life Sciences Division Project Control Board review 5/18/00.**
    - **On-Orbit operations shall be conducted**
    - **Experiment data shall be disseminated to PI teams**

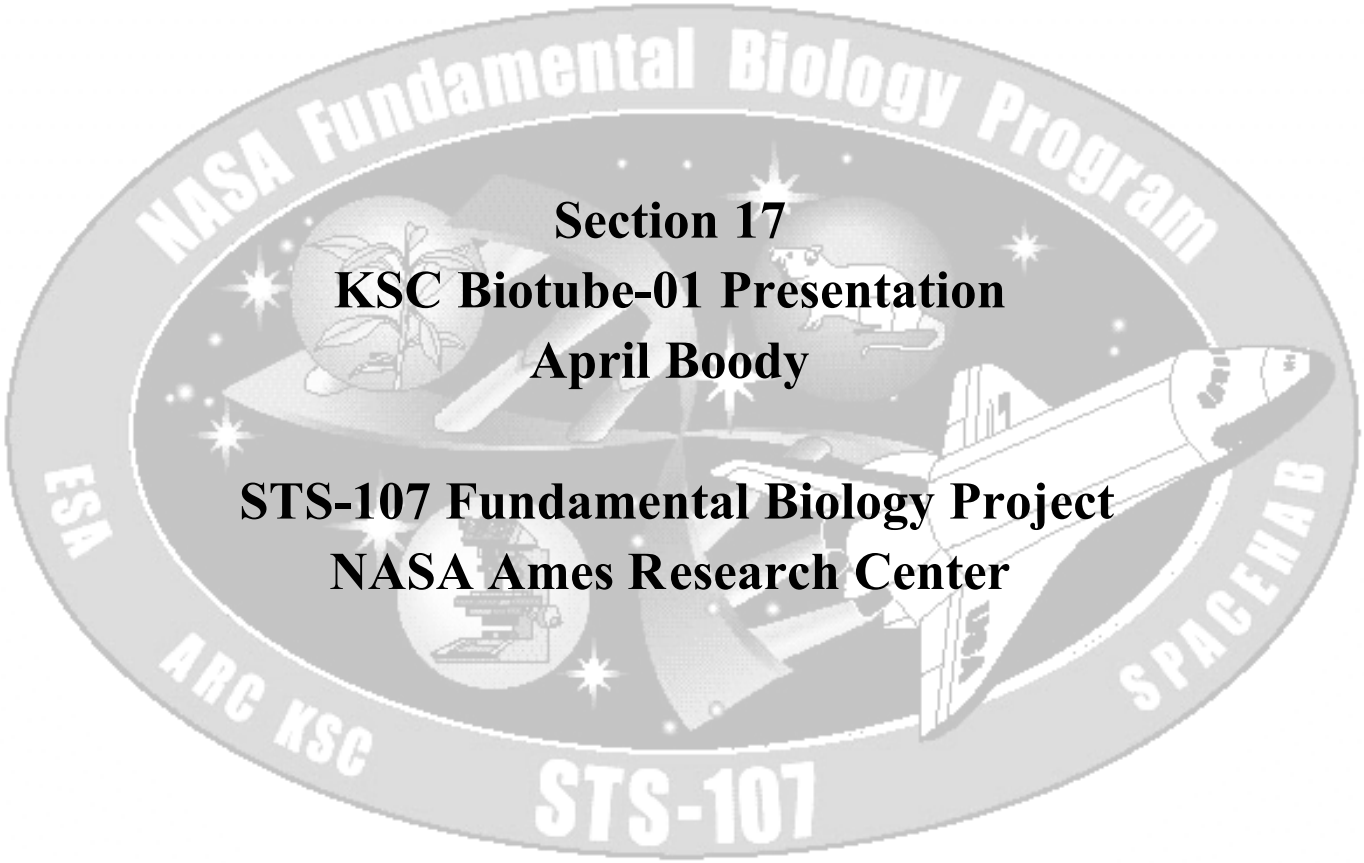
- **Project Requirements (Continued)**
  - **AEM/Biopack Hardware Requirements**
    - **AEM H/W design and operations shall meet science requirements as defined in individual Experiment Requirements Documents.**
      - **Status: Work in progress**
    - **AEM CO_2 System shall provide the crew with a safe and rapid means of euthanizing rodents in the event of an animal crisis.**
      - **Status: Work in progress**
    - **Biopack hardware shall meet science requirements as defined in the ERD**
      - **Status: Work in progress**

- **Project Requirements (Continued)**
  - **Operations Requirements**
    - **Hardware shall be fabricated, modified, and refurbished to meet objectives identified in the Experiment Requirement Documents.**
      - **Status: Work in progress**
    - **Hardware shall be prepared to support crew training.**
      - **Status: Schedule impacted by hardware modifications**
    - **Training of crew shall be supported by STS-107 Fundamental Biology Project personnel.**
      - **Status: Schedule impacted by hardware modifications**
  - **Safety Requirements**
    - **The identification and mitigation of hazards shall be accomplished to achieve mission success for the STS-107 SPACEHAB mission.**
      - **Status: Work in progress**

ARC Development Status

Ames Research Center

- **Challenges**
  - **Indeterminate status of two PIs.**
    - **Chapes is being considered for manifesting and is an unknown risk for support at this late date.**
    - **Vandenburgh is on reserve and risk of supporting manifesting increases with time.**
  - **Change in scope of project by inclusion of CO_2 system and Inflight Refill Unit and back-up unit.**
    - **Significant increase in stowage requirements and cost.**
    - **Meeting SPACEHAB deliverables.**



Section 17
KSC Biotube-01 Presentation
April Boody

STS-107 Fundamental Biology Project
NASA Ames Research Center

Biotube-01 Phase A/B Agenda

- Science Requirements
- Hardware Requirements
- Mission Requirements
- Payload Configuration
- Resource Summary
- Mission Testing Plan
- Integrated Experiment Schedule
- Procedures
- Crew Training Readiness
- Budget
- Biotube Precursor

Biotube-01 Team

- **Payload Mission Manager**
  NN-L1-LS: David Cox
- **Project Scientist**
  JJ-G: William Knott
- **Project Engineer**
  BIO-8: April Boody
- **Hardware Engineer**
  BIO-3: Ken Anderson
- **Project Science Coordinator**
  DYN-3: Howard Levine
- **Principal Investigator**
  University of Louisiana: Karl Hasenstein

Biotube-01 Payload Overview

- **Investigator: Dr. Karl Hasenstein, University of Louisiana at Lafayette**
- **Science and Hardware Management: KSC**
- **First flight of Biotube-01 hardware**
- **Experiment Objective: To use magnetic fields to influence the growth of plant roots in microgravity**
- **Hardware Objective: To imbibe seeds, take video images of roots, and fix seedlings. Temperature data will be recorded, but not controlled. All Biotube-01 hardware functions are computer controlled**
- **Authorization to proceed to Phase B granted in September 1996**

Biotube-01 Science Requirements - Description/Objectives

- To determine if amyloplasts are the organelle in plant cells that perceive gravity
- To determine whether the intracellular position of amyloplasts in the absence of gravity affect spatial growth orientation
- To determine if gravity exerts a controlling effect on the deposition of wall material in plant cells

Biotube-01 Science Requirements -

Hypothesis:

The hypotheses to be tested include the determination of whether or not:

- **The positioning of amyloplasts in statocytes of the columella region of the root cap determines the future growth direction of the root**
- **The microtubular and F-actin cytoskeleton is affected by microgravity**

Biotube-01 Science Requirements

Experiment Overview

- **The gravisensing system, specifically the role of amyloplasts, will be studied by applying directional stimuli using high gradient magnetic fields (HGMF), which enable the displacement of amyloplasts**

- **The investigator's research has shown that *in vitro* and *in vivo* amyloplasts move along the gradient of the magnetic field**

- **Aside from studying the application of HGMF in directional growth control, the experiments will test whether the force exerted by amyloplasts of their position inside sensory cells controls the direction of growth**

Biotube-01 Science Requirements - Status

KSC Testing

- Science Verification Test #1 ran for three days in November 1998 - prototype hardware used
  - Hardware/science biocompatibility issue prevented seed germination
- Science Verification Test #2 ran for 11 days in December 1999 - prototype hardware used
  - No biocompatibility issues
  - PI states hardware will support proposed science

PI Ground Testing

- Extensive testing using Magnetic Field Chamber hardware to determine required magnetic field strength
- Clinostat studies

Biotube-01 Hardware Requirements - Hardware Performance Requirements Summary

The Biotube-01 payload will use the newly developed Experiment Unique Equipment Magnetic Field Apparatus hardware system for spaceflight experimentation

The Hardware will perform the following operations:

- **Initiate a pre-programmed imbibition of seeds on-orbit by the precise delivery of a specified quantity of water**
- **Expose the resulting seedling roots to high gradient magnetic fields**
- **Record digital images of root growth**
- **Deliver a fixative to the seedlings to terminate the experiment prior to re-entry**

Hardware Requirements - Hardware List

Generic External Shell

- Structural interface, replaces single middeck locker

Generic Containment Unit

- Provides three redundant levels of containment for contents

Magnetic Field Chamber

- Each contains eight seed cassettes/64 seeds per MFC

Micro-Effusion Delivery Unit for Space Applications

- Delivers water to seed cassettes in MFCs

Fixative Delivery System

- Delivers fixative sequentially to each MFC

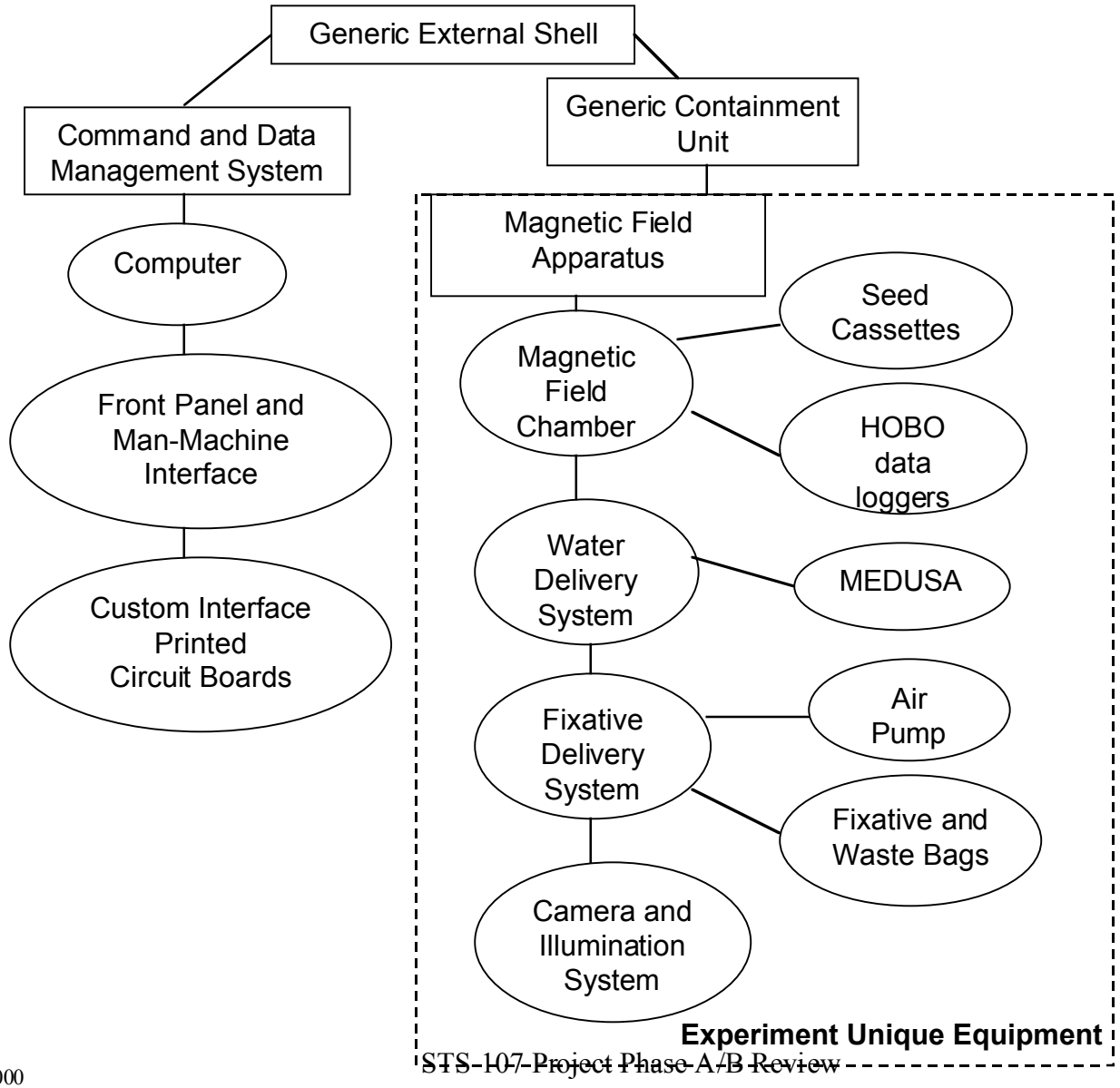
Digital Imagery System

- Four digital cameras to record images of roots as they pass through the magnetic field

Command and Data Management System

- Provides automated control of payload operations

Biotube - 01 Hardware Summary

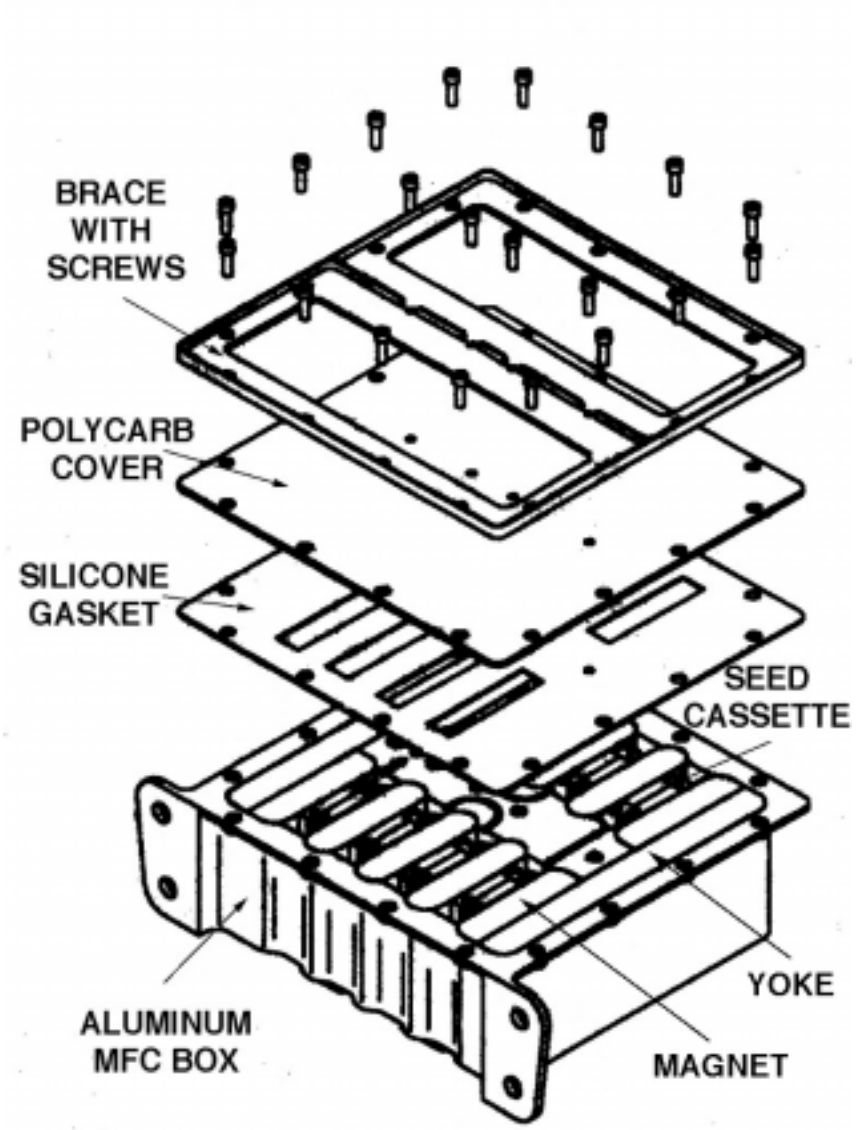


Magnetic Field Chamber

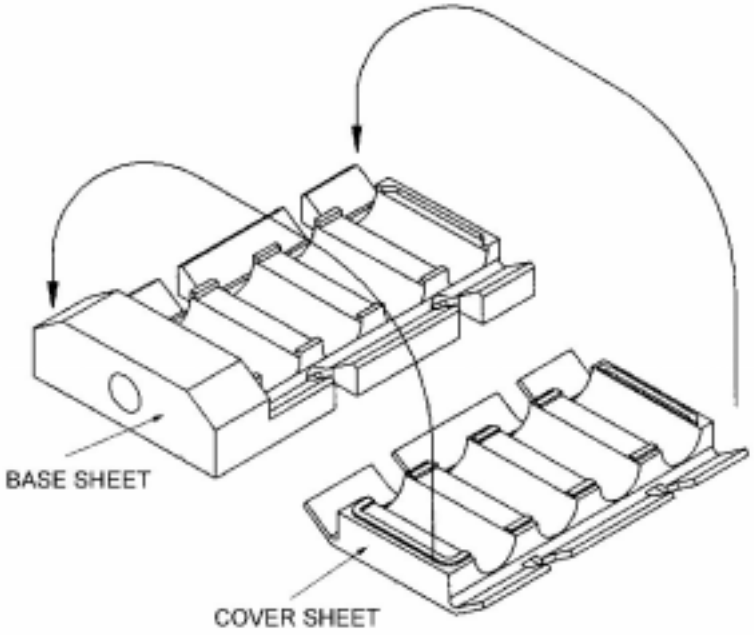
- **Three MFCs total, each contains 10 neodynium iron boron permanent magnets. Two steel yokes on each MFC strongly attenuate stray magnetic fields from leaking outside MFC**

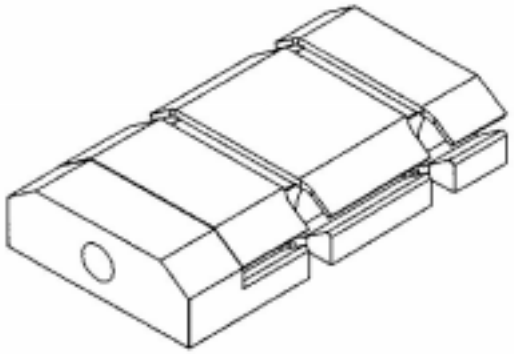
- **Each MFC contains eight polycarbonate seed cassettes**

Magnetic Field Chamber



Seed Cassette





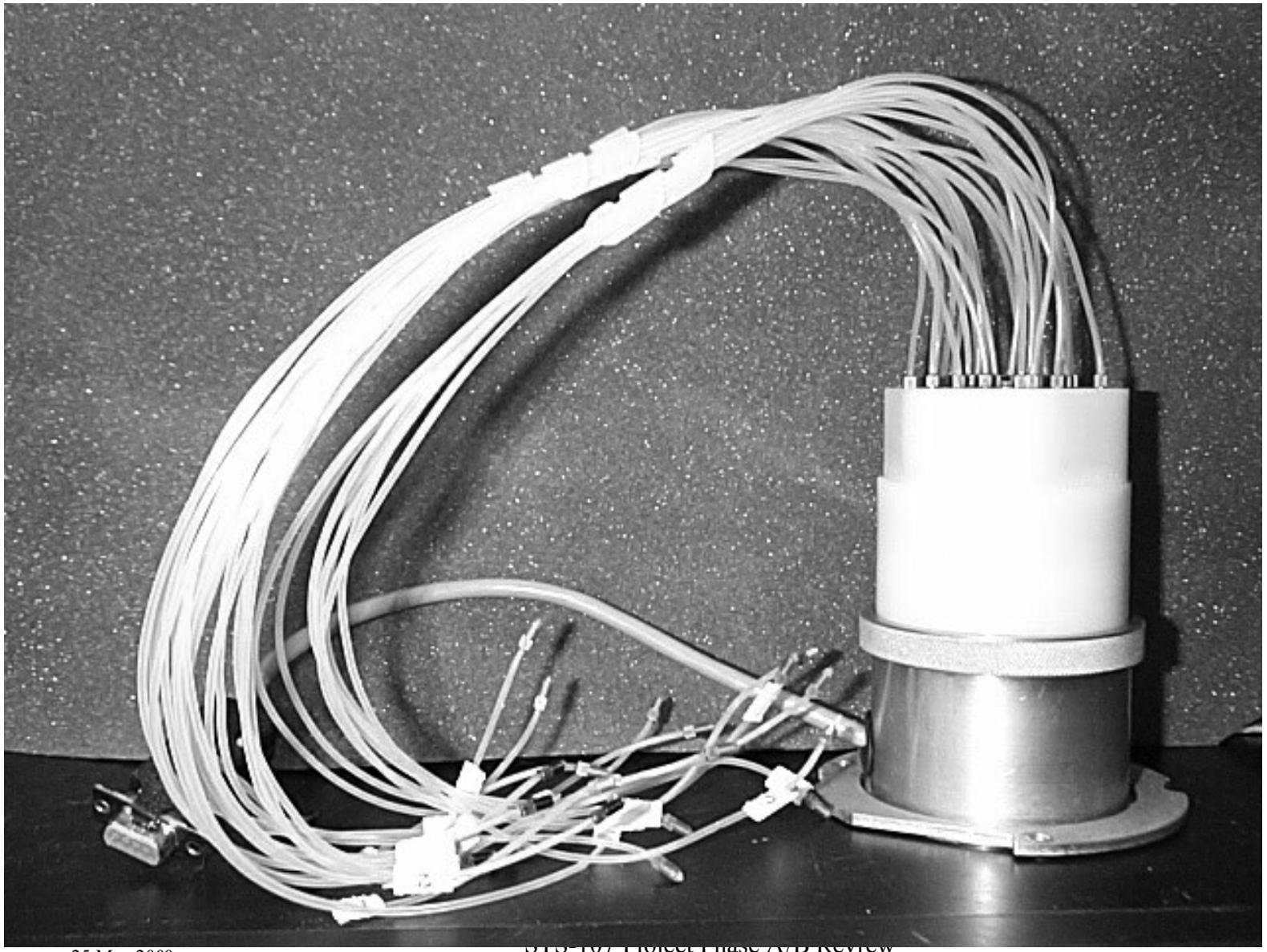
ASSEMBLED VIEW

Micro-Effusion Delivery Unit for Space Applications

- **MEDUSA has a total of twenty-four Teflon tubes attached to the top. Individual Teflon tubes run to each seed cassette located in each MFC**

- **A stepper motor delivers 50 µL of water at a time to the seed cassettes, 600 µL total water volume per seed cassette**

Micro-Effusion Delivery Unit for Space Applications



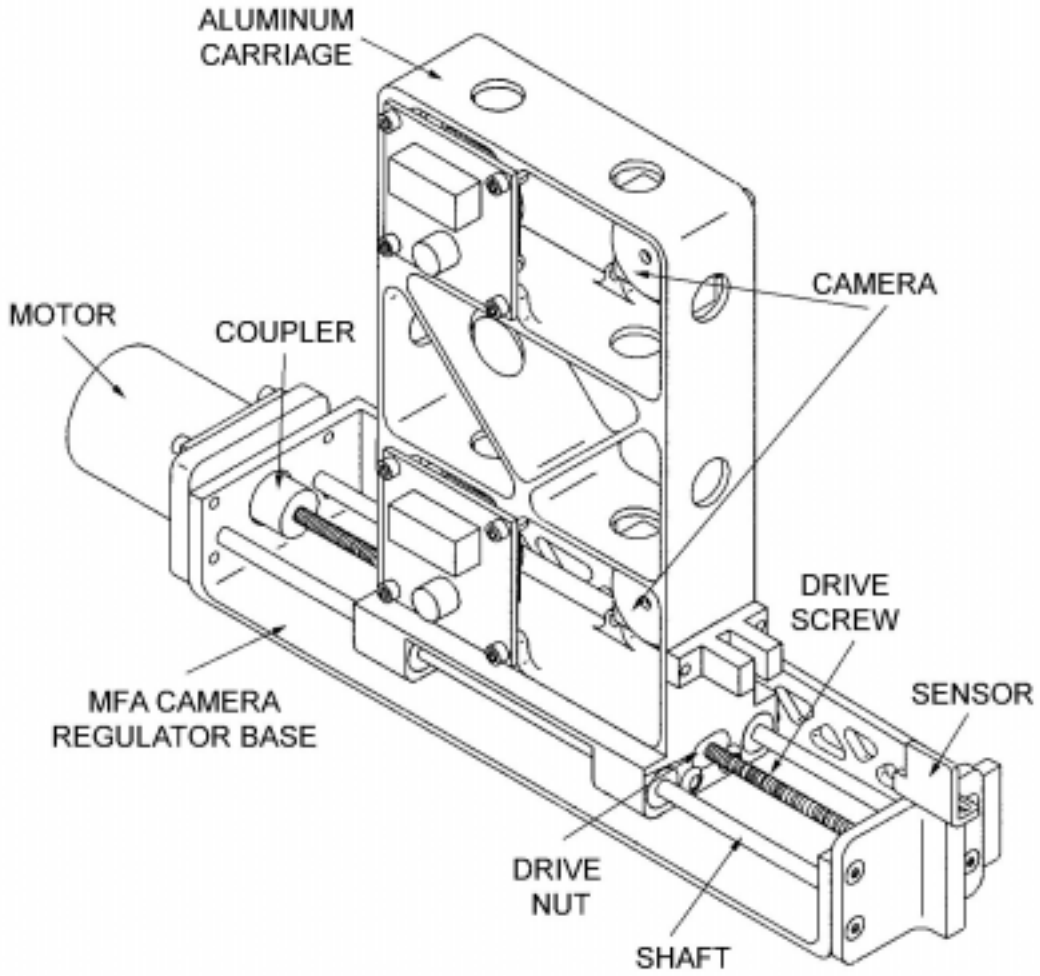
Fixative Delivery System

- Three fixative bags (4% formaldehyde, 96% PHEMD buffer) contained in Storage Container
- An air pump pressurizes the Storage Container, causing fixative to flow from bags and to MFCs
- MFCs fill one at a time by fixative flowing serially around all seed cassettes

Camera and Illumination System

- Composed of four CCCD cameras and four infrared Light Emitting Diodes
- The camera carriage travels along a drive screw
- Lights turn on, cameras take images, lights turn off, camera carriage travels to next position
- Images are recorded for approximately 38 hours

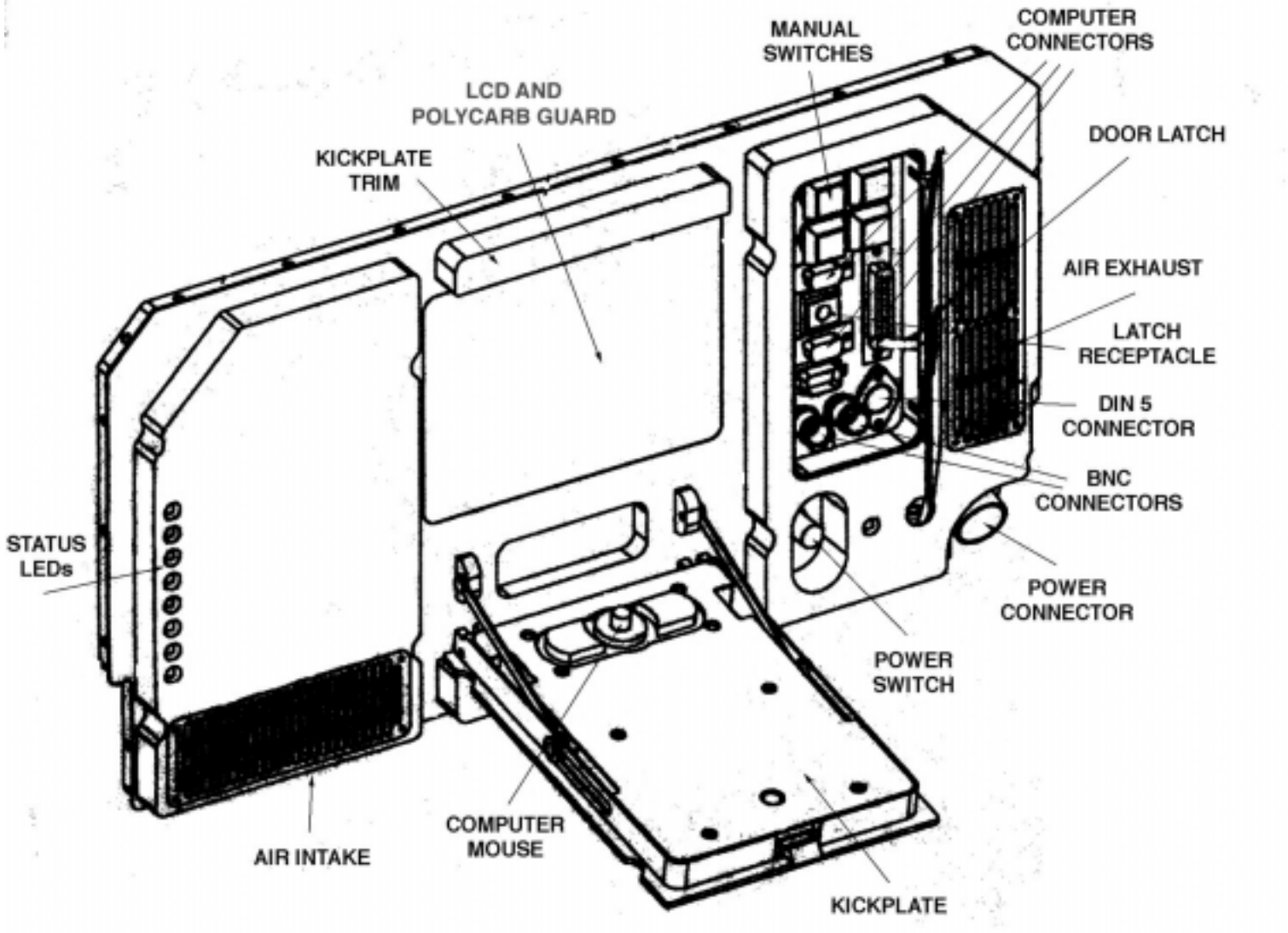
Camera and Illumination System



Hardware Interfaces

- **The Biotube-01 payload requires a 28 VDC power connector. Power is only required during the 48 hour Biotube-01 operations**
- **Crew interface is via the front panel man-machine interface**
- **Crew turns power on to initiate experiment, performs status checks, and turns experiment off following fixation. Once initiated, all Biotube-01 operations are controlled by the Command and Data Management System (CDMS). Manual override switches are available for crew use in the event of a CDMS failure**

Hardware Interfaces



Hardware Development Status

- PDR complete - February 1998
- CDR complete - March 2000
- Phase 0/1 Flight Safety Review complete - January 2000
- ERD baseline - April 2000
- Flight hardware fabrication complete - June 2000
- End-to-End testing/PI clinostat test - August 2000

Mission Requirements

- Installation at L-36 to L-32 hours
- Scrub Turnaround: 96 hours
- Runway removal prior to Orbiter tow at R+3-5
- Power required: On-orbit only
- Total payload operating time: maximum 48 hours
- Experiment can be initiated at any time during the mission, prefer as close to R-2 days as possible to minimize fixative degradation
- Support required at both primary and secondary landing sites beginning 10 hours after experiment initiation
- Ground control: Will utilize KSC Orbiter Environmental Simulator to mimic the middeck/SPACEHAB cabin environment with a 96 hour delay

Payload Configuration

Facility Hardware

- Biotube-01 hardware

Stowage/EUE

- None

Resource Summary

Power Profile

- 28 VDC power required on-orbit during Biotube-01 operations only; no ascent or descent power
- Maximum continuous power: 60 W
- Peak power: 88 W (during camera lighting activities)

Thermal

- Requires a location not adjacent to a heat producing payload/equipment

Mass Properties

- Total single locker weight less than 70 pounds

Crew Time

- Minimal Crew time for initiation, status checks, and termination

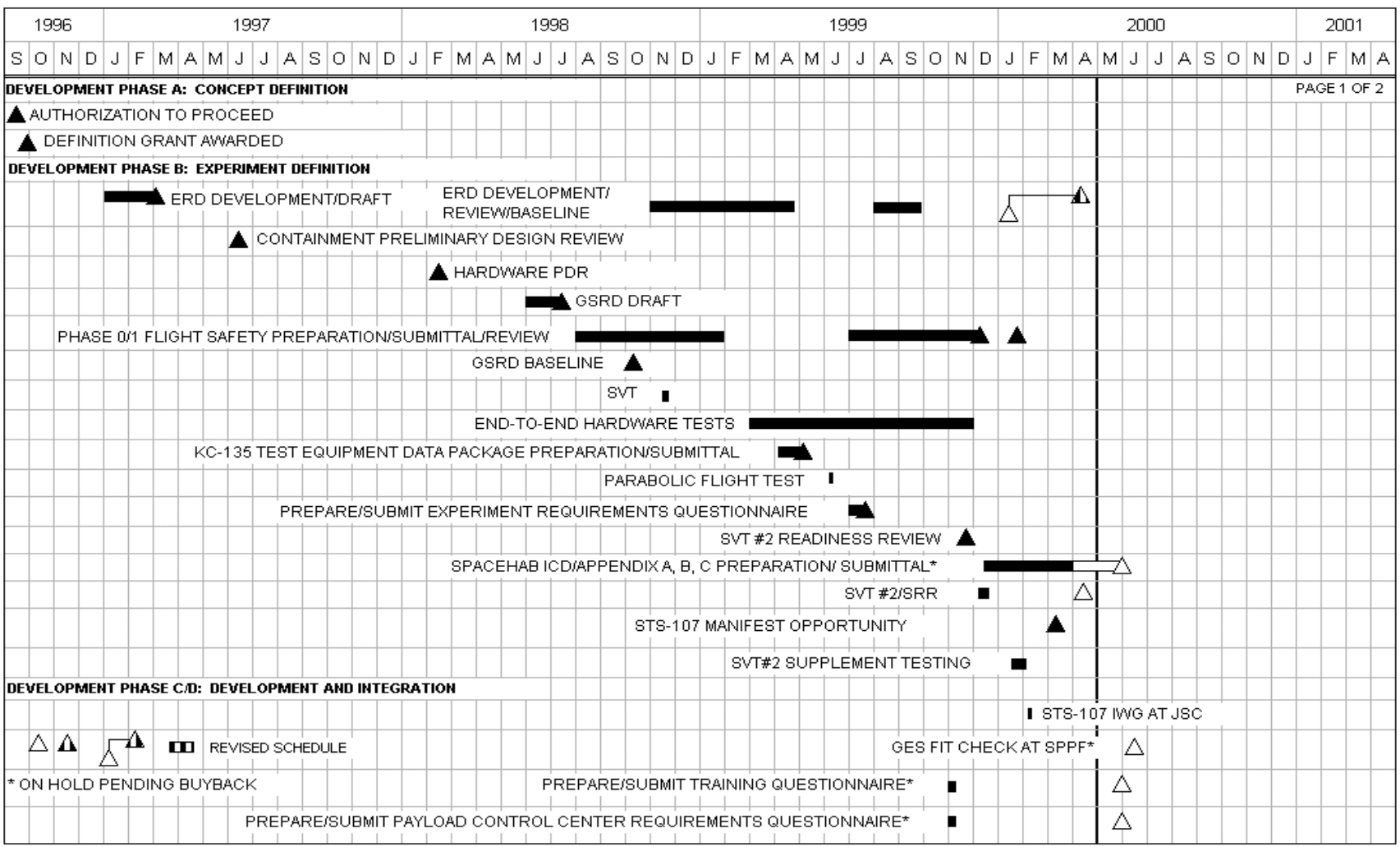
Mission Testing Plan

- SVT complete - January 2000
- PVT target - Late October/early November 2000

Biotube-01 Schedule

Mar 31, 2000

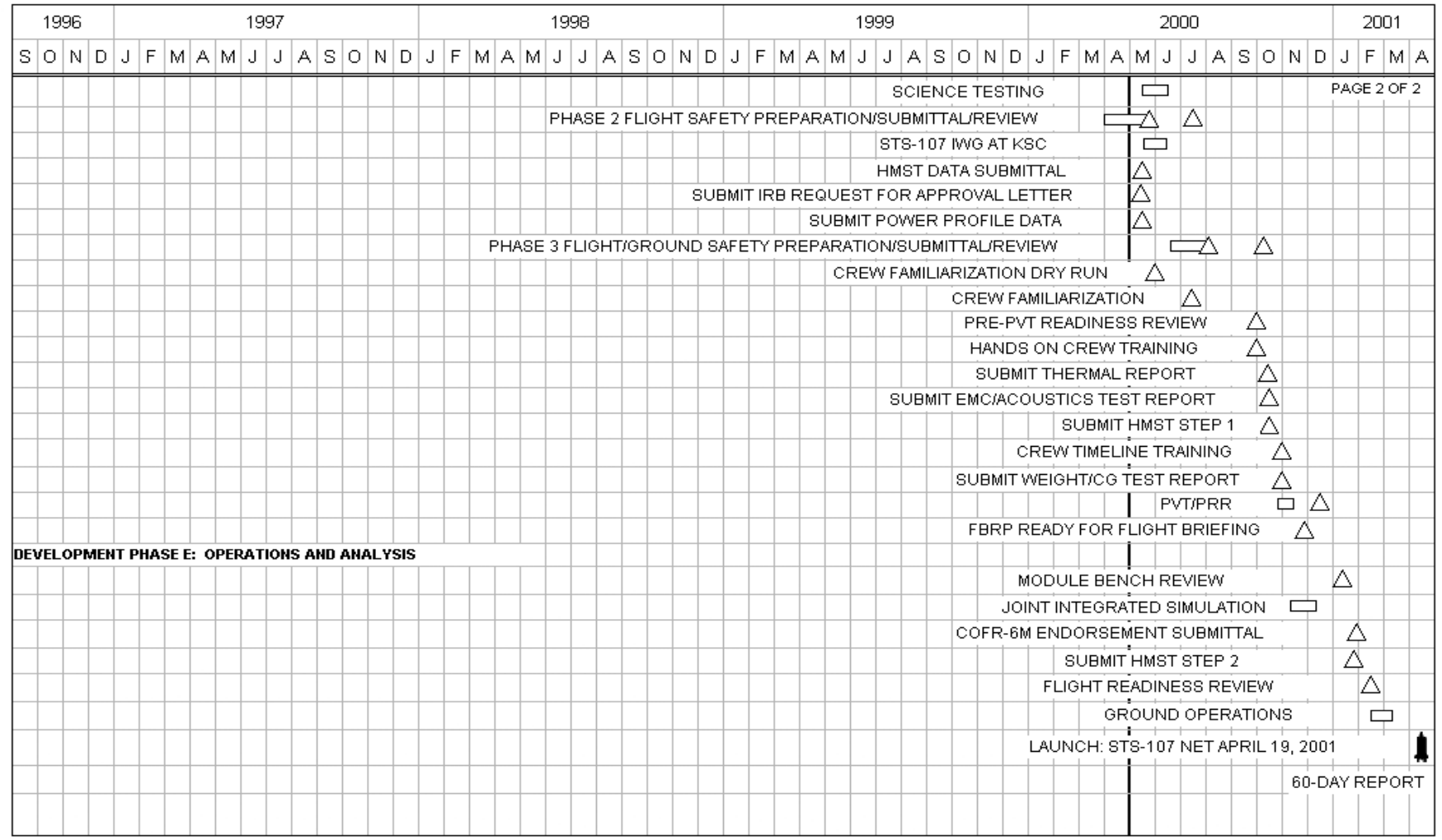
FLIGHT EXPERIMENTS PROJECT MANAGEMENT
KENNEDY SPACE CENTER
BIOTUBE/MAGNETIC FIELD APPARATUS (MFA-1)



Biotube-01 Schedule (Cont'd)

Mar 31, 2000

FLIGHT EXPERIMENTS PROJECT MANAGEMENT
KENNEDY SPACE CENTER
BIOTUBE/MAGNETIC FIELD APPARATUS (MFA-1)



Biotube - 01 Procedures

- Initiate experiment by turning power on
- Monitor experiment progress/status checks
- Terminate experiment by turning power off
- In the event of a Command and Data Management System failure, the crew will manually initiate imbibition and fixation

Biotube - 01 Crew Training Readiness

- Crew training will be performed using flight hardware
- Earliest expected crew training readiness: July 2000

Biotube - 01 Budget

PI budget complete

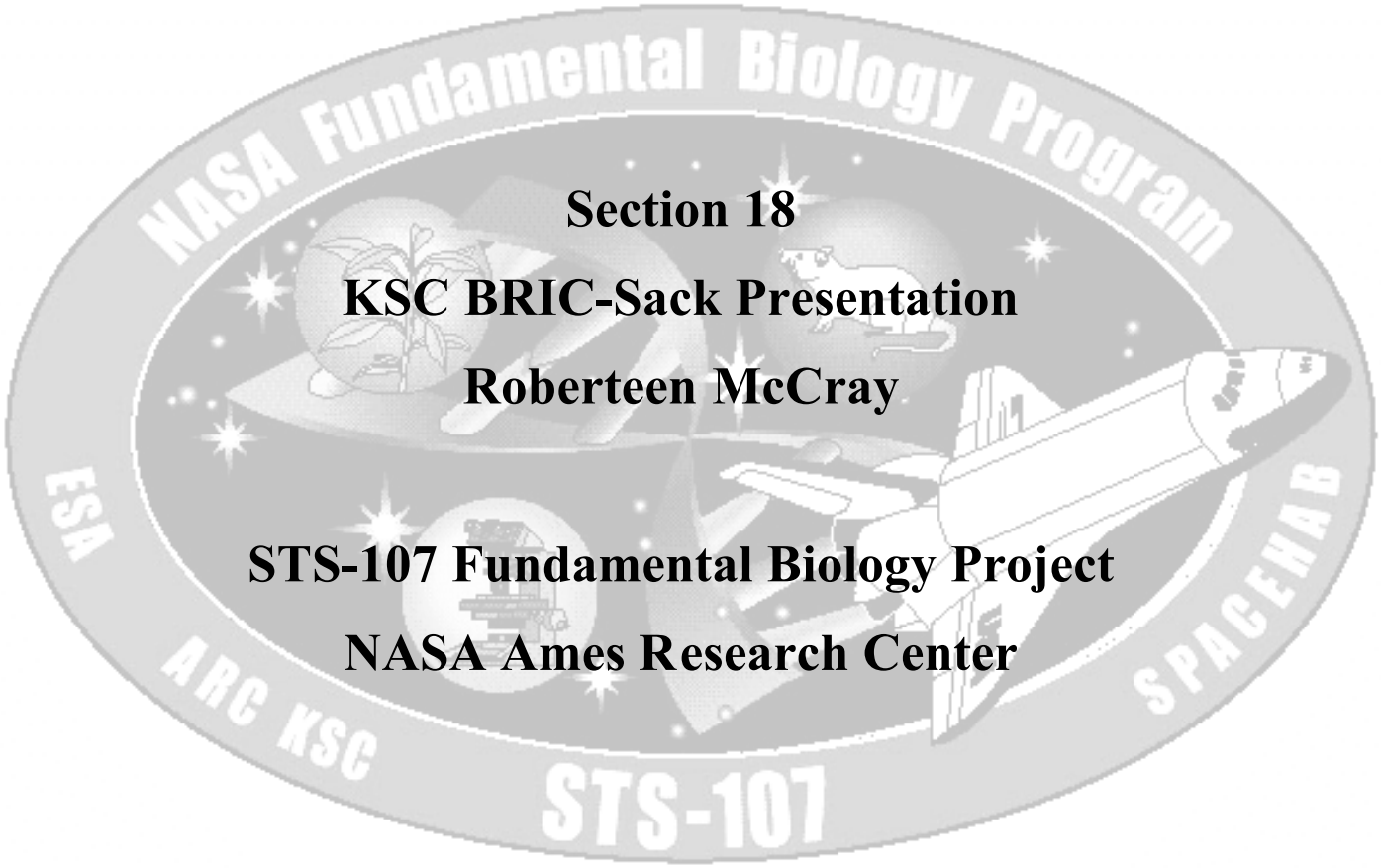
- Approved by Program Office and Technical Monitor
- Grant Agreement funded
- Period of performance: FY00

Project budget complete

- Submitted in POP cycle

Biotube Precursor on STS-101
Space Shuttle Program Status

- Flight and Ground Safety Packages have been reviewed and approved. All Flight Safety Package Verification Tracking Log (VTL) items are closed. A Ground Safety VTL was not required
- Crew familiarization and Bench Review are complete
- Certificate of Flight Readiness (COFR) submitted in February 2000
- Turnover of Biotube Precursor tray scheduled for Monday, May 15, 2000
- STS-101 is schedule to launch at 6:33 a.m. EDT



Section 18

KSC BRIC-Sack Presentation

Roberteen McCray

STS-107 Fundamental Biology Project

NASA Ames Research Center

BRIC-Sack Phase A/B Agenda BRIC-Sack Phase A/B Agenda

- BRIC-Sack Team
- Science Requirements
- Hardware Requirements
- Mission Requirements
- Payload Configuration
- Resource Summary
- Mission Testing Plan
- Integrated Experiment Schedule
- Procedures
- Crew Training Readiness
- Budget

BRIC-Sack Team

- **Payload Mission Manager**
  - **NN-L1-LS: Bridgit Higginbotham**
- **Project Scientist**
  - **JJ-G: William Knott**
- **Project Engineer**
  - **BIO-8: Roberteen McCray**
- **Hardware Engineers**
  - **BIO-3: Bill Wells/Charlie McFarland**
- **Project Science Coordinator**
  - **DYN-3: Howard Levine**
- **Principal Investigators**
  - **Ohio State University: Fred Sack**
  - **Ames Research Center: Volker Kern**

BRIC-Sack Payload Overview

- **Investigators: Dr. Fred Sack, Ohio State University; Dr. Volker Kern, Ames Research Center**
- **Science and Hardware Management: KSC**
- **Series reflight of the BRIC hardware**
- **Experiment Objective: To identify factors that contribute to the non-random orientation and distribution of amyloplasts in the tip of moss *Ceratodon* cells.**
- **Hardware Objective: To provide a sterile environment for the moss to grow until the delivery of the inhibitor and fixative is complete. Temperature data will be recorded, but not controlled.**
- **Authorization to proceed to Phase B granted in March 1999.**

BRIC-Sack Science Requirements - Description/Objectives

- To confirm that spiral growth of moss cells is a predictable response to microgravity.
- To determine whether the cytoskeleton plays a role in maintaining and generating an apical (non-random) plastid distribution in microgravity.
- To determine the age at which clockwise growth starts to be expressed by comparing dark treatments to pre-orienting red light treatments.

BRIC-Sack Science Requirements - Hypothesis

The hypotheses to be tested include the determination of whether or not:

- **Older moss cultures produce spiral growth in shorter periods of exposure to microgravity than younger moss cultures.**
- **Both microtubules and microfilaments are required for maintaining a non-random distribution of amyloplasts in microgravity.**
- **In microgravity gravitropism and phototropism in low intensity light are separable from each other.**

BRIC-Sack Science Requirements - Experiment Overview

- **Cultures will be grown in the dark to determine the threshold exposure to microgravity for the expression of spiral growth of the moss.**
- **Cultures will be grown under low red light intensities to examine the interaction between gravitropism and phototropism.**
- **The analysis of whether non-random amyloplast distribution requires cytoskeletal integrity, by applying inhibitors followed by chemical fixation *in situ*.**

BRIC-Sack Science Requirements - Status

KSC Testing

- Science Verification Test - April 19 - May 9, 2000
  - In progress

PI Ground Testing

- Extensive testing using different inhibitors, chemical fixative concentrations and light intensities are continuing.

BRIC-Sack Hardware Requirements - Hardware Performance Requirements Summary

The BRIC-Sack payload will use the existing BRIC-LED hardware including existing Petri Dish Fixation Units and Experiment Unique Equipment Petri Dish Fixation Units for space flight experimentation.

The Hardware will perform the following operations:

- **Provide a sterile environment for moss growth.**
- **Provide a two-stage delivery system for the inhibitors and fixative prior to re-entry.**
- **Provide low level directional light.**
- **Provide three redundant levels of containment for hazardous materials.**

Hardware Requirements - Hardware List

Custom Stowage Tray
- One half middeck locker aluminum tray. Provides forced airflow and mounting for BRIC-LEDs

BRIC-LED Canisters (8)
- Each canister contains six positions for Petri Dish Fixation Units and data logger

Petri Dish Fixation Units (47)
- Houses the petri dish in which the moss cultures are planted

Inhibitor/Fixative Delivery System
- Delivers inhibitor and/or fixative to each petri dish

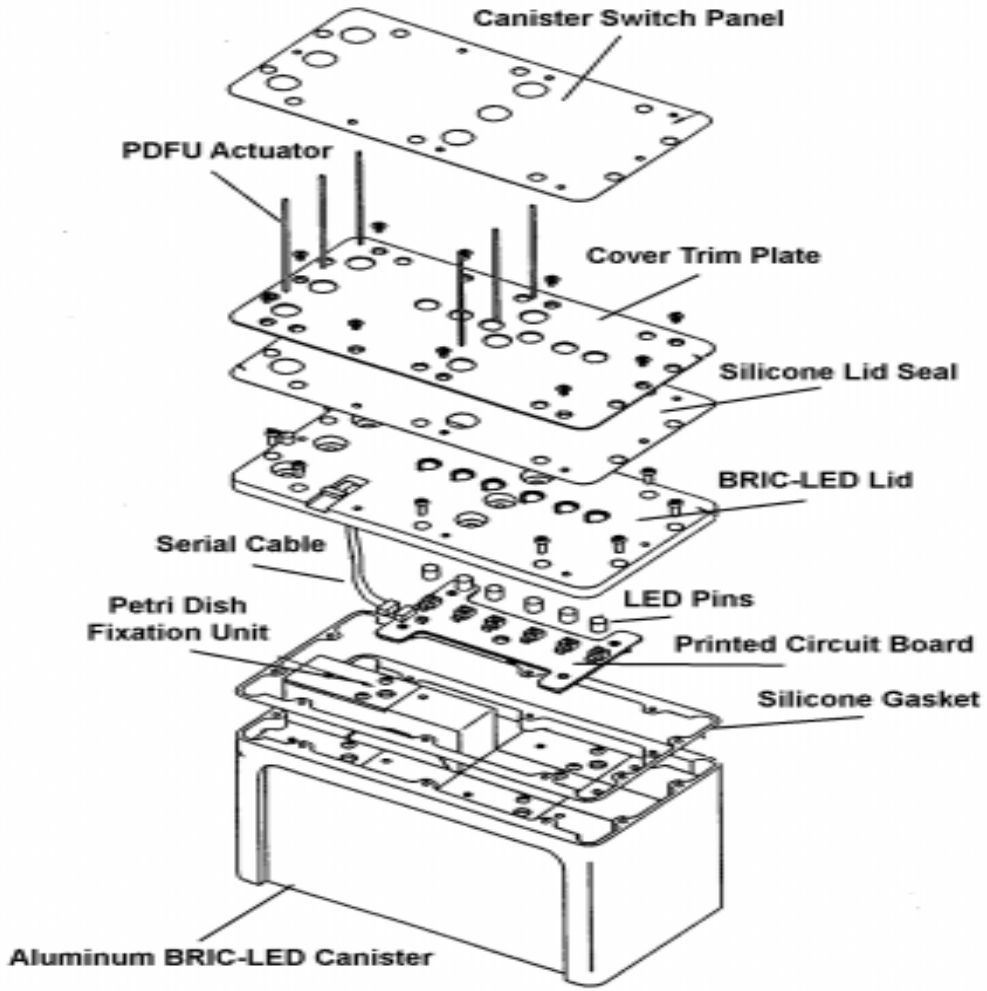
Actuator Tool and Rods
- Initiates the delivery of the inhibitor and/or fixative

HOBO
- Temperature Data Logger for passive recording

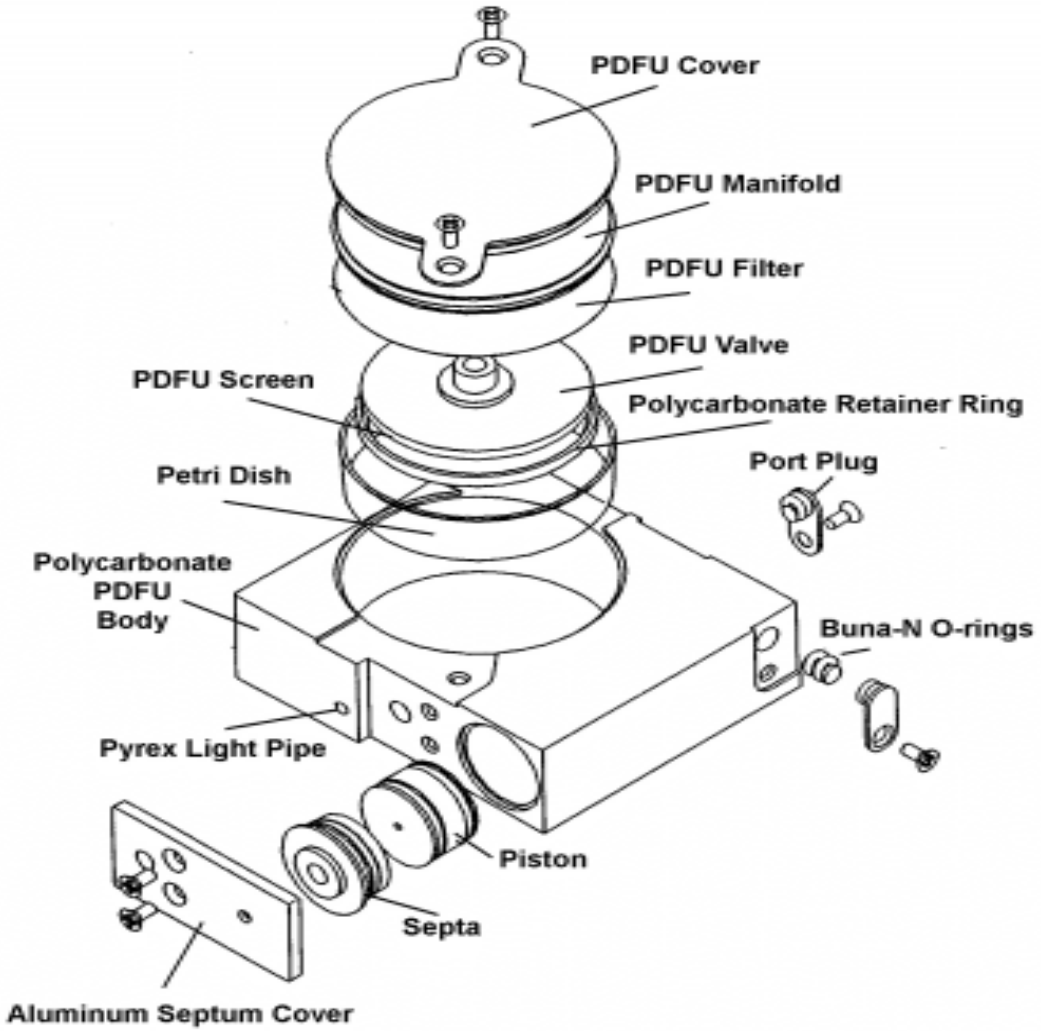
BRIC - LED

- Eight BRIC-LEDs contain six PDFUs each.
- Thirty PDFUs will be the originally designed version used during CUE.
- Seventeen PDFUs will be the modified version which has a two stage inhibitor/fixative delivery system.
- A HOBO Temperature Data Logger will be located in one PDFU slot.

BRIC - LED

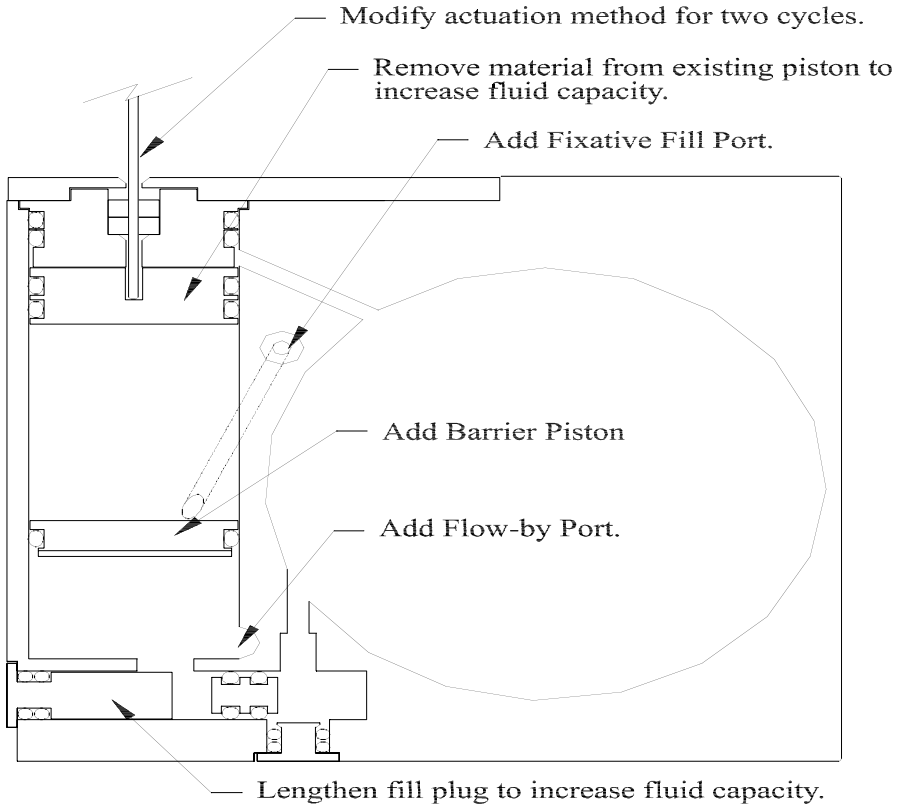

Canister Switch Panel
PDFU Actuator
Cover Trim Plate
Silicone Lid Seal
BRIC-LED Lid
Serial Cable
LED Pins
Petri Dish
Fixation Unit
Printed Circuit Board
Silicone Gasket
Aluminum BRIC-LED Canister

PDFU
(Petri Dish Fixation Unit)



Modified PDFU Inhibitor/Fixative Delivery System

SACK modifications to existing PDFU hardware



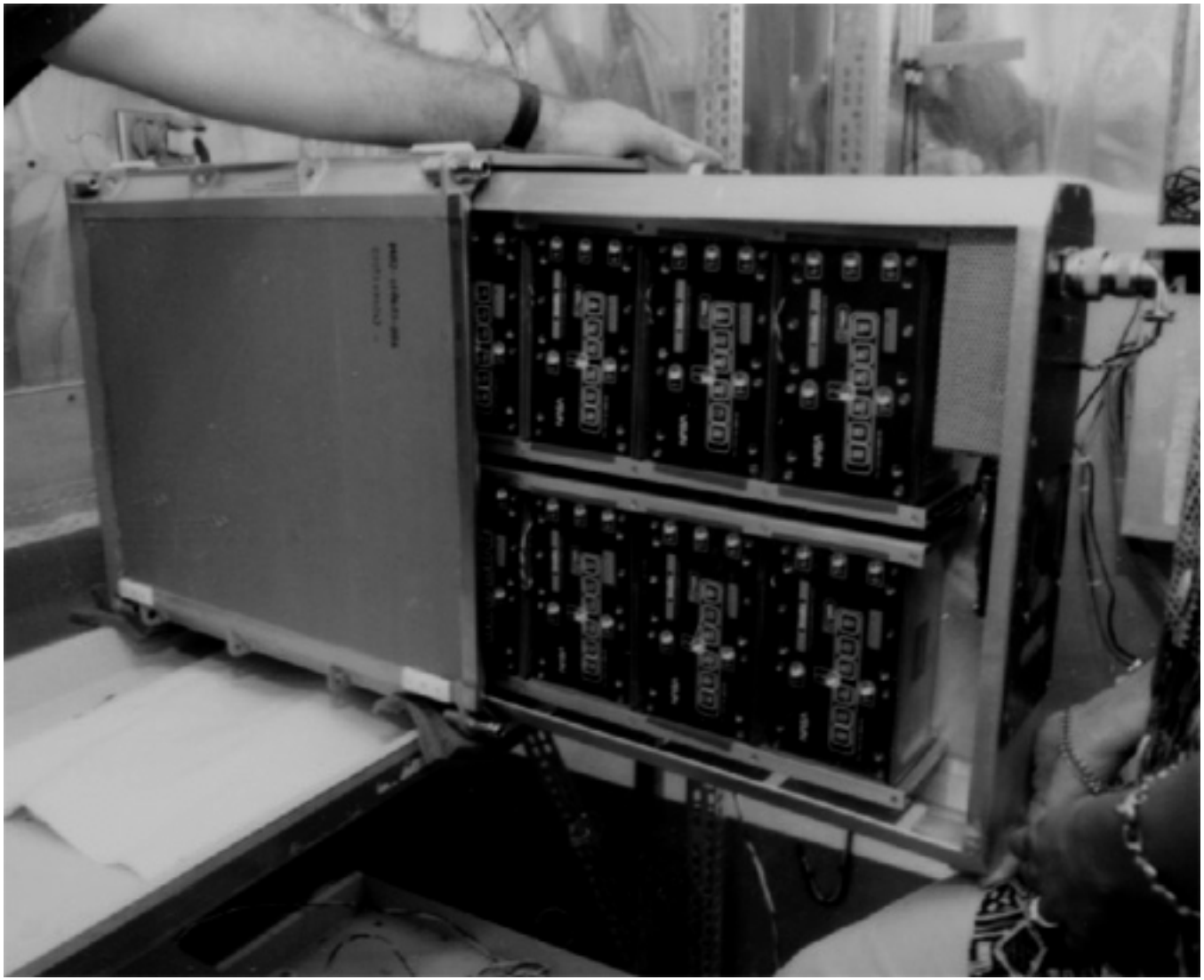
No changes adversely affect current operating parameters

SACK Concept
Sht 1 of 3
02/25/1999

Hardware Interfaces

- **The BRIC-LED payload requires a 28 VDC power source.**
- **Crew interface is via the front panel man-machine interface.**
- **Crew turns the LEDs on and off on selected canisters, and performs the inhibitor and/or fixative delivery in each PDFU.**

Hardware Interfaces



Hardware Status

- **Flight Hardware Fabrication (modified PDFUs) - July 2000**
- **Phase 3 Series/Reflown Flight Safety Review - September 2000**

Mission Requirements

- **Installation at L-19 to L-17 hours**
- **Scrub Turnaround: 24 hours**
- **Runway removal prior to Orbiter tow at R+ 3 - 5**
- **Power required: Assent and FD 8 - 9**
- **Total payload operating time: L-7 d to L+1, R-2 d**
- **Experiment will be initiated seven days prior to launch**
- **EEOM support required at both primary and secondary landing sites beginning after launch**
- **Ground control: Will utilize KSC Orbiter Environmental Simulator to mimic the middeck cabin environment with a 24 hour delay**

Payload Configuration

Facility Hardware

- BRIC-LED hardware
- Occupies a single half-locker tray equivalent

Stowage/EUE

- None

Resource Summary

Power Profile

- 28 VDC power required on-orbit during Flight day 1 and Flight days 8 and 9; no descent power
- Maximum continuous power: 30 W
- Peak power: 40 W

Thermal

- Requires a location not adjacent to a heat producing payload/equipment

Mass Properties

- 45 pounds

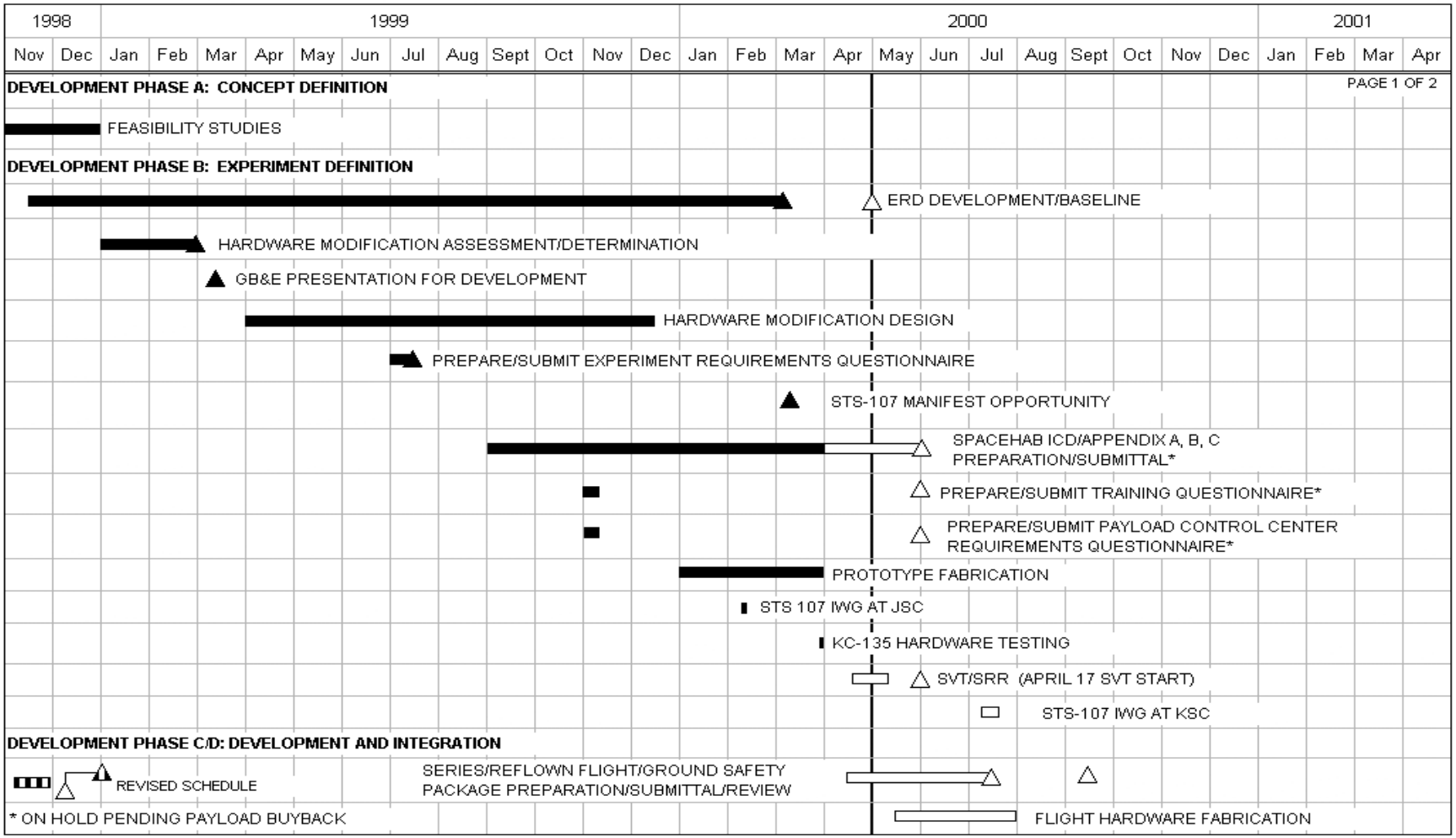
Mission Testing Plan

- **SVT complete - May 2000**
- **PVT target - Late September/early October 2000**

BRIC-Sack Schedule

Mar 31, 2000

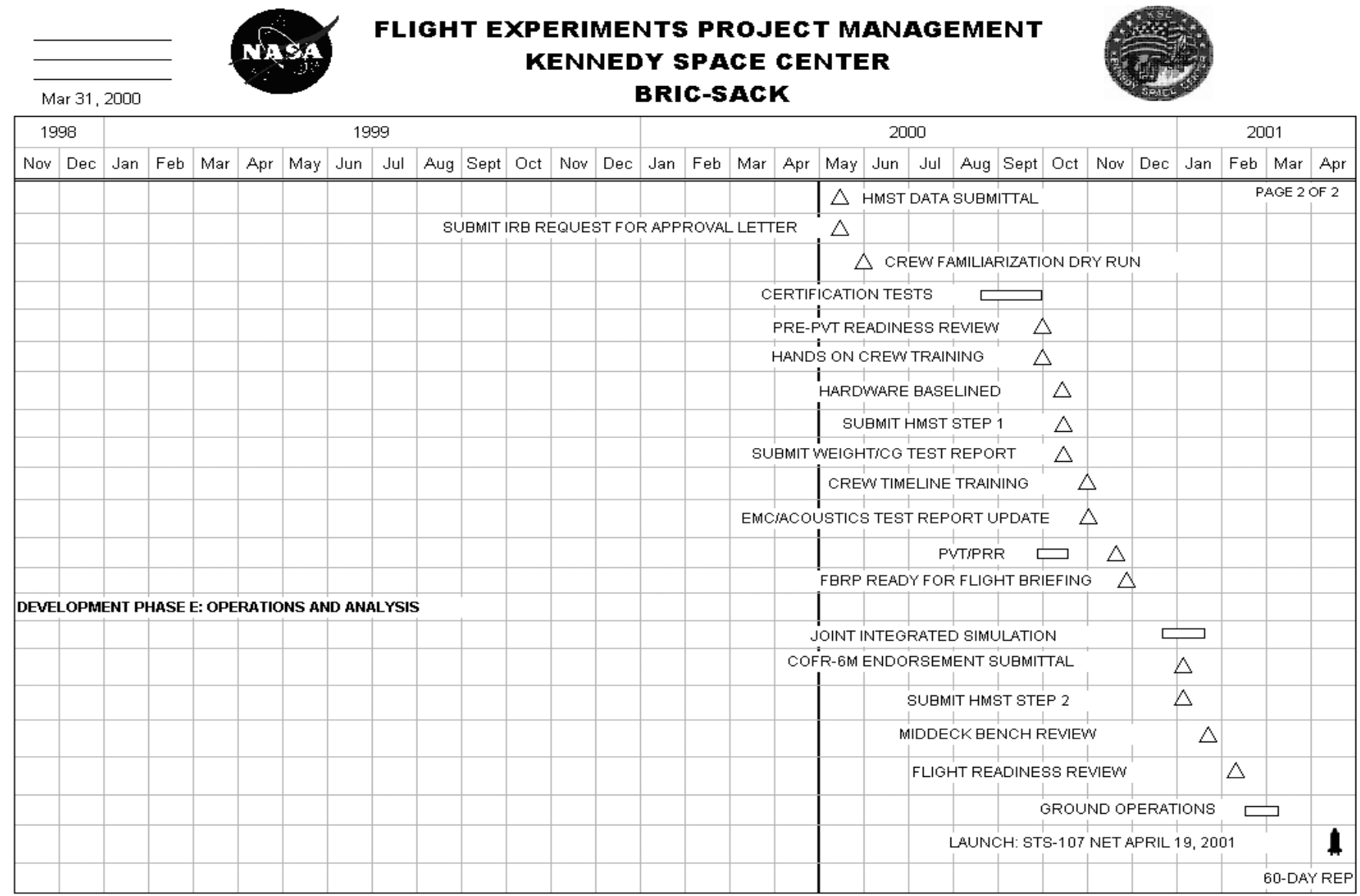
FLIGHT EXPERIMENTS PROJECT MANAGEMENT
KENNEDY SPACE CENTER
BRIC-SACK



BRIC-Sack Schedule (Cont'd)

Mar 31, 2000

FLIGHT EXPERIMENTS PROJECT MANAGEMENT
KENNEDY SPACE CENTER
BRIC-SACK



BRIC-Sack Procedures

- **Initiate experiment by turning the lights off in designated BRIC-LED canisters.**
- **Monitor experiment progress/status checks.**
- **Turn the lights on in designated BRIC-LED canisters.**
- **Terminate experiment by delivering all inhibitors and fixatives.**

BRIC-Sack Crew Training Readiness

- **Crew training will be performed using flight hardware.**
- **Earliest expected crew training readiness: July 2000**

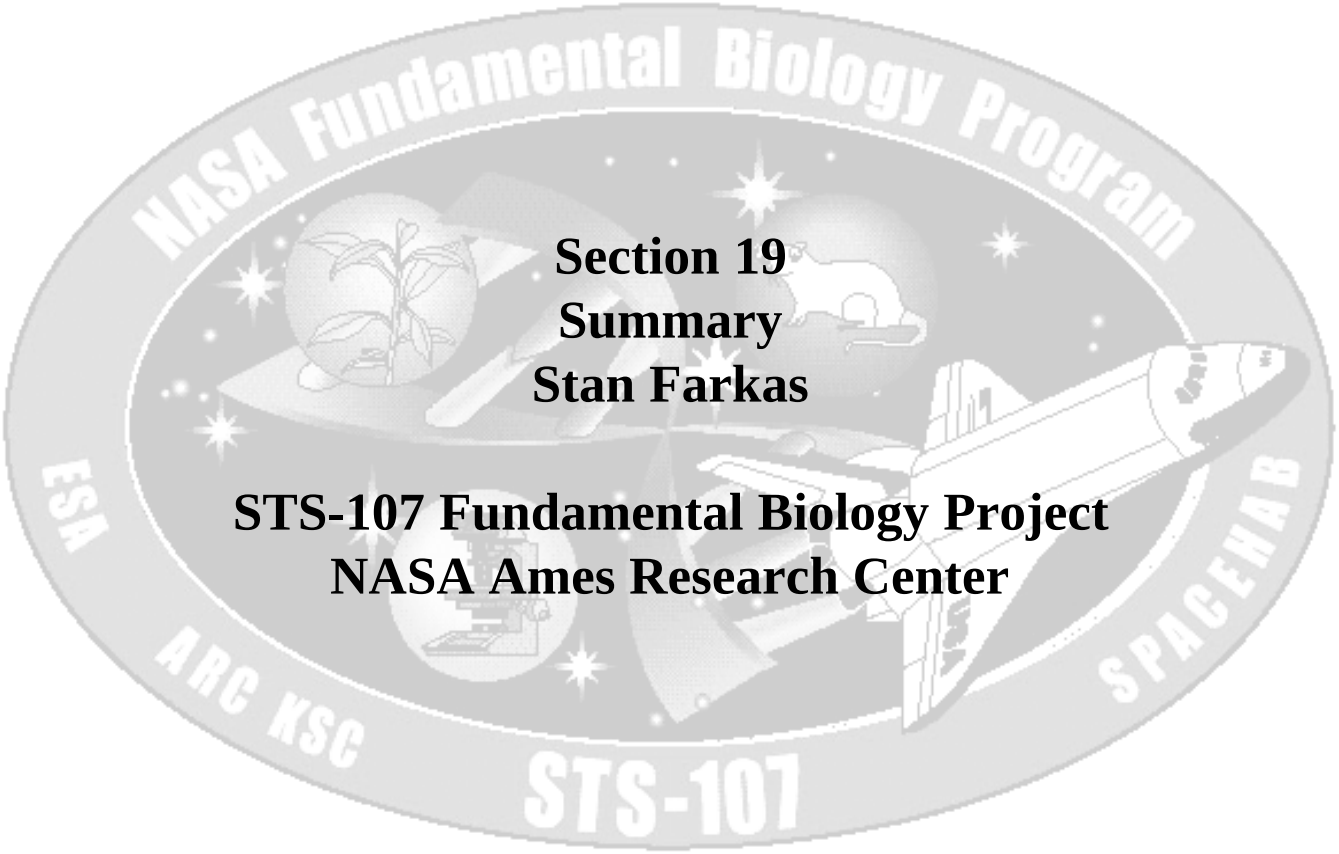
BRIC-Sack Budget

PI budget complete

- **Approved by Program Office and Technical Monitor**
- **Grant Agreement funded**
- **Period of performance: FY00**

Project budget complete

- **Submitted in POP cycle**



Section 19
Summary
Stan Farkas

STS-107 Fundamental Biology Project
NASA Ames Research Center

Acronym list

ACOS- AEM CO2 System

AEM - Animal Enclosure Module

ARC- Ames Research Center

ASSY-Assembly

ARF- Aquatic Research Facility

ATP- Adenosine Triphosphate

BRIC- Biological Research In Cannisters

BRIC-LED- Biological Research in Canisters-Light Emitting Diode

cCMP-Guanosine Cycline Monophoshate

CCM- Cell Culture Module

CDMS- Command Data Management System

CDR- Critical Design Review

CIS-Camera Illumination System

CM-Centimeter

CO2-Carbon Dioxide

CRIT- Criteria

CSA- Canadian Space Agency

CSF- Cerebral Spinal Fluid

CWR-Collapsible Water Reservoir

DIAM-DIAMETER

DIS-Digital Imagery System

EEOM- Early End of Mission

ELISA- Enzyme-linked immunosorbent assay

ERD-Experiment Requirements Document

ESA- Europen Space Agency

EST- Experiment Sequence Test

EUE- Experiment Unique Equipment

EVT- Experimental Verification Test

FDS- Fixative Delivery System

FAM- Familiarization (BRIEFING)

FD- Flight Day

FO- Functional Objective

FPU-Fluid Pumping Unit

FRESH- Fundamental Rodent Experiments Supporting Health

FRR- Flight Readiness Review

FTR- Facilities Trial Run

g- Gravity

GCU- Generic Containment Unit

GES- Generic External Shell

HGMF- High Gradient Magnetic Fields

H/W - Hardware

Acronym list

IACUC- Intstitutional Animal Care & Use Committee

ICD- Interface Control Document

IN-Inch

IRB- Institutional Review Board

IRU-Inflight Refill Unit

KSC- Kennedy Space Center

Launch - Launch Minus

L+ Launch Plus

LIOH-Lithium Hydroxide

LIRD- Logisctics Integrated Requirements Document

LOE- Level of Effort

M-Meter

MEDUSA- Micro-Effusion Delivery Unit for Space Applications

MET- Mission Elapsed Time

MFA -Magnetic Flux Apparatus

MFC- Magnetic Field Chamber

MLE-Middeck Locker Equivalent

MMO- Mission Management Office

MOU-Memoranum of Understanding

MSDS-Material Safety Data Sheets

N/A-Not Applicable

NaK- Sodium Potassium

NCR-Non-Conformance Reports

NET- No Earlier Than

NOS- Nitric Oxide Synthase

OBJ- Objective

OSRF- Oceaneering SPACEHAB Refrigerator Freezer

PDFU's- Petri Dish Fixation Units

PCB-Project Control Board

PDR- Preliminary Design Review

PI- Principal Investigator

POP- Program Operating Plan

PMR-Payload Management Review

PSR- Pre-Ship Review

PSRP-Payload Safety Review Panel

PSI-Pounds Per Square Inch

PSIG-Pounds Per Square Inch Gauge

PT-Process Traveler

PWQ-Process Waste Questionnaire

PVT- Payload Verification Test

Acronym list

QD-Quick Discount

QTY-Quantity

RPO- Research Program Office

R+ Recovery plus

SL- Life Science Division of Ames Research Center

SS&MA- System Safety and Mission Assurance

SORG-Shuttle Orbiter Repackaged Galley.

SPF- Specific Pathogen Free

STS- Space Transport System

SVT-Science Verification Test

SWG- Science Working Group

TAP- Test & Assembly Procedure

TBD-To be determined

TOP-Test Operating Procedure

VDC- Volt Direct Current

VIV- Vivarium

WBS- Work Breakdown Structure