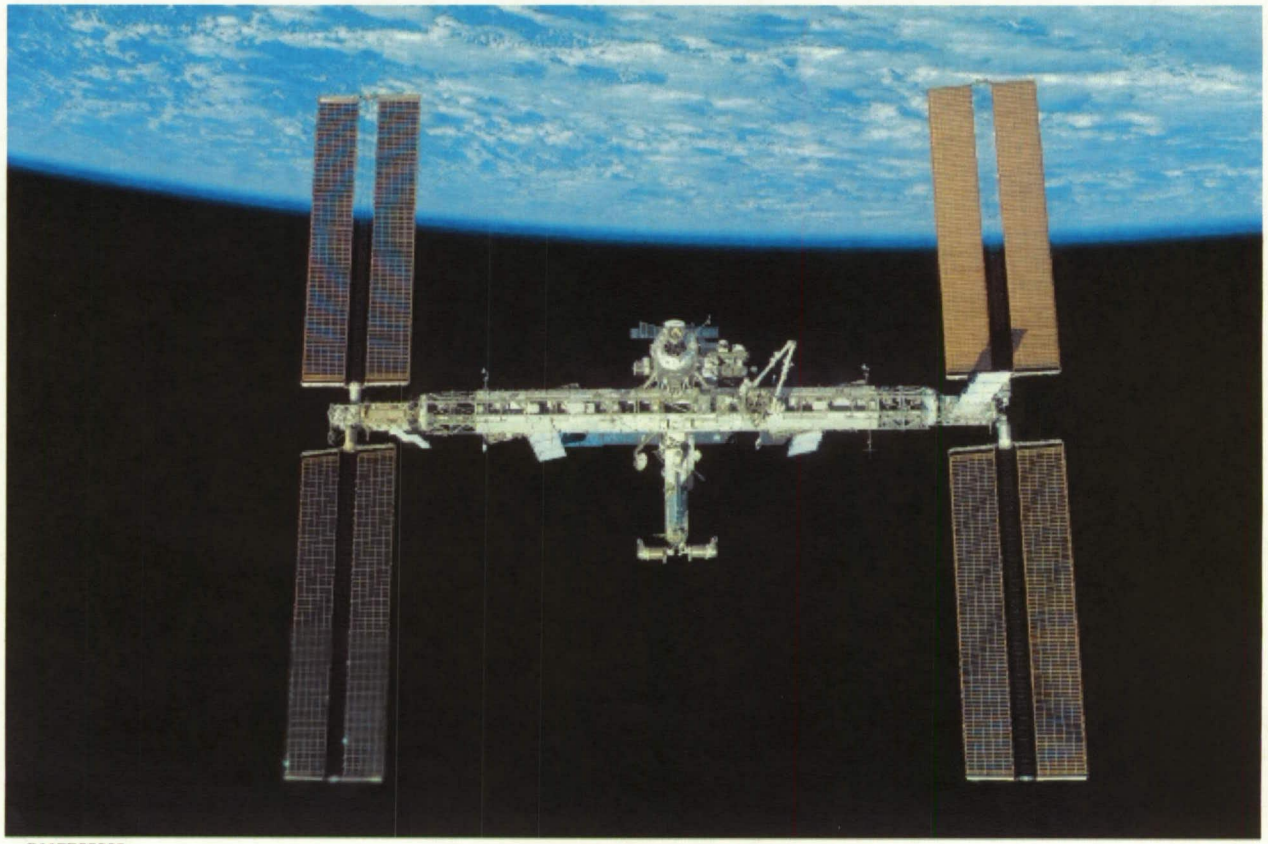
ISS National Laboratory



S117E08003

Agenda

- National Lab Concept
  - Research by Non NASA US participants
  - Roles of participants
- ISS Configuration and Capability
  - Space Assets
  - Ground Assets
- Proposed Process for Usage
- Near Term activities
  - Recent past
    - NIH MOU
    - ARC Conference
    - Demonstration investigations
  - Near future
    - Visits and Meetings
    - Additional Customer Development
- Discussion

ISS National Lab Concept

- Established by Congress
  - "Of particular interest is the application of the United States (U.S.) portion of the International Space Station (ISS) as a national laboratory, as established by P.L. 109-155. The designation as a National Laboratory underscores the significance and importance that the U.S. places on the scientific potential of the ISS for research…"
  - NASA shall continue to operate the U.S. ISS resources and provide 50 percent of the U.S. resource to non NASA activities
  - U.S. non NASA users will fund their PI's, develop experiment unique hardware, and procure processing and access resources

Time Line

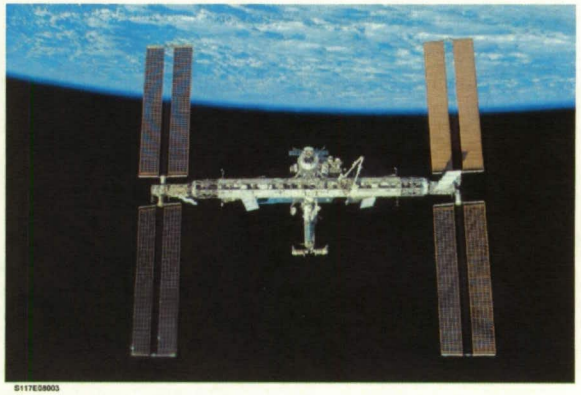
2016 ISS National Lab Operations Decision Execution

2014 ISS National Lab Operations Decision Point

2011 ISS National Lab Operations begin

2010 ISS Assembly complete

Now



Micro Gravity Potential Fields of Study

- Studies in the absence of gravity and its effects
  - Molecule Biology
    - The Aging Process
    - Infectious Disease
    - Medicine
  - Material Processing
  - Crystal Development
- Studies using the unique conditions of space
  - Radiation effects
  - Energy generation and transmission in Zero-Gravity and Vacuum
- Studies using the unique observation point
  - Ecological observations

Potential National Lab Customers

Physical Processes Customers

- Combustion Science
- Fluid Physics
- Materials Science
- Dust Aggregation
- Earth Observation

Basic Biology Customers

- Molecular Biology
- Cell Biology
- Microbial Ecology
- Gene & Protein Expression

Private Industry Customers

- Private Space Hardware Developers
  - Offers cost-effective hardware & experiment *pre-ISS* test flights.
  - Reduces risk to space operations technology development.
- Pharmaceuticals (crystal formation in Micro-g)
- Biotechnology Product Development
- Computer Chip Materials Development
- Cosmetic Firms (novel product development)

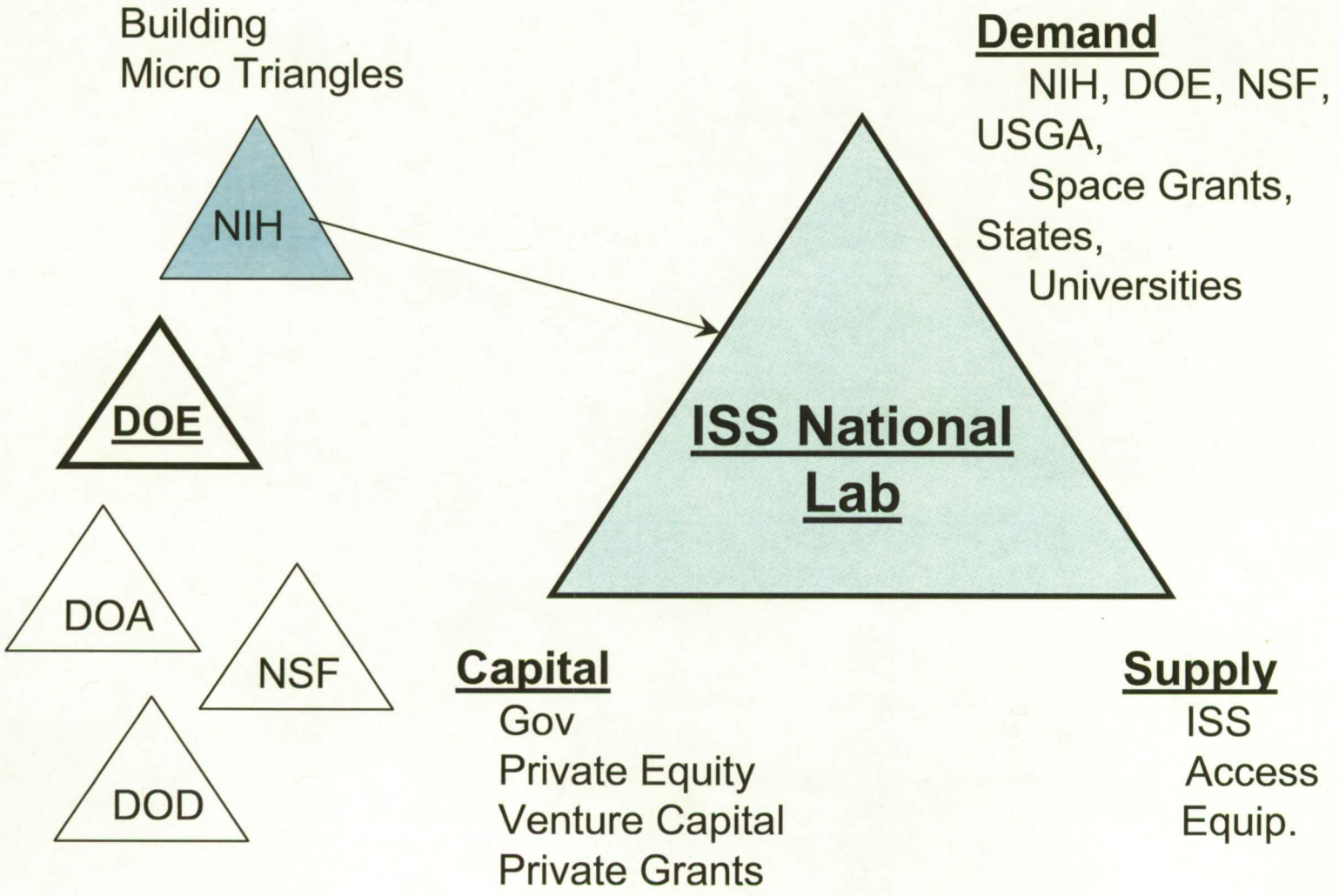
NASA

- Directly supports ESMD technology development.
- Assessment of SOMD "technologies that enable…flight testing of developmental hardware and software."
- Contributes to growth and success of ISS user base (National Lab Initiative).
- Provides SMD "Novel Platforms" by frequent, cost-effective access to suborbital microgravity environment.
- Education/Outreach: Rocket program not only provides hands on experience, it generates a new generation of explorers *and* supporters.
- National Space Grant Consortium

Other Government Agencies

- Department of Agriculture
- Department of Energy
- Department of Defense
- National Institutes of Health
- National Science Foundation

Building the National Lab Customer Base



ISS National Lab Resource
50 percent of U.S. Share

ISS Post Assembly Complete Payload Accommodations

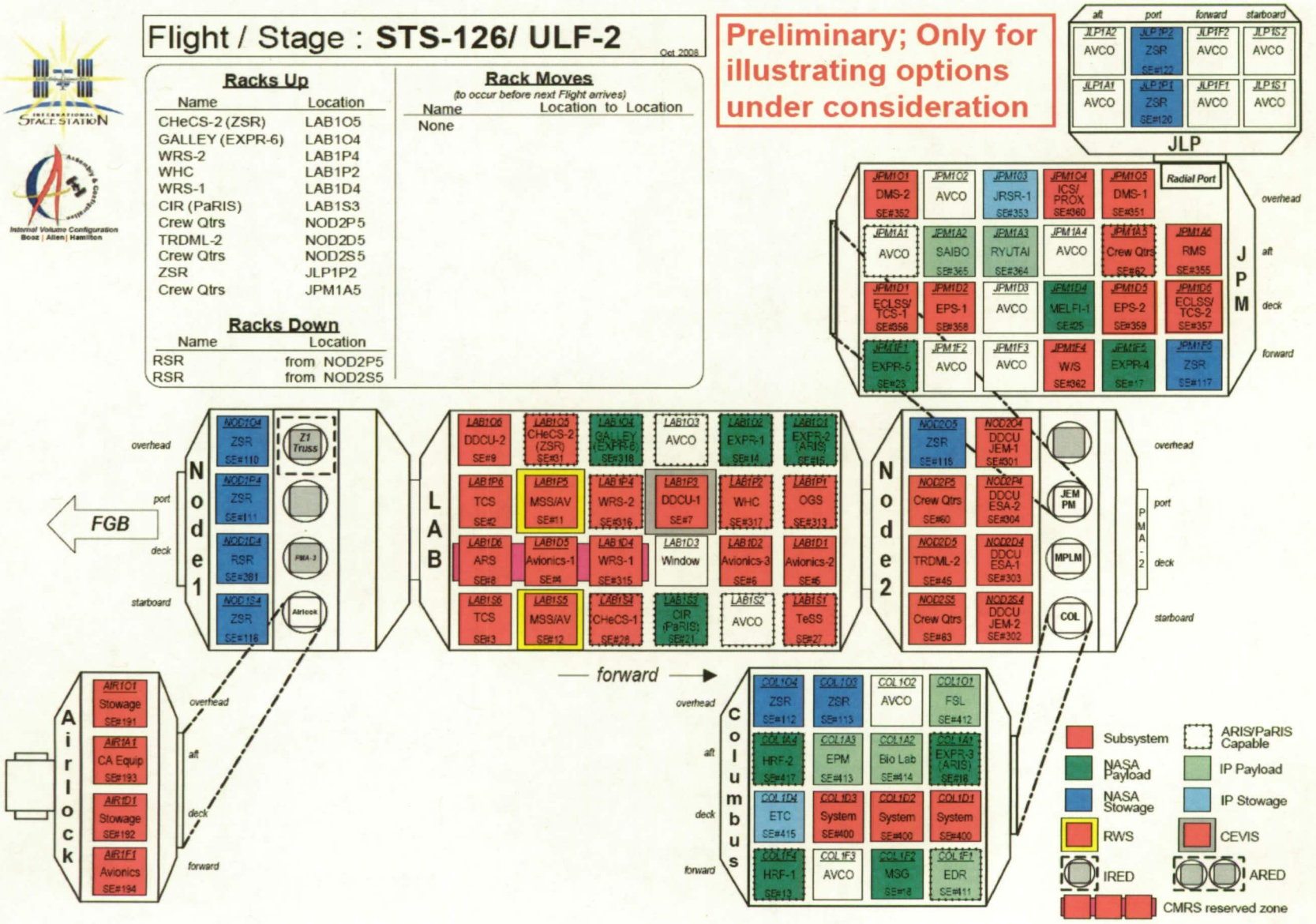
Internal Pressurized Rack Sites	Station-Wide	U.S. Share
U.S. Laboratory	13 ISPRs *	13 ISPRs
Japanese Experiment Module	11 ISPRs	6 ISPRs
European Columbus Orbital Facility	10 ISPRs	5 ISPRs
Total	34 ISPRs	24 ISPRs
External Un-pressurized Attachment Sites		
U.S. Truss	10 sites	10 sites
Japanese Exposed Facility	10 sites	5 sites
European Columbus Orbital Facility	4 sites	0 sites
Total	24 sites	15 sites
Utility Resources		
Power/thermal:		25 kW_{avg}
Data Transmission**:		150 Mbps downlink (Ku band)
Transmission coverage:		70 – 75% of orbit
Crew time:		35 hours/week
Transportation:		In work

Microgravity Science Glovebox &
EXPRESS Rack 3A

*ISPR: International Standard Payload Rack
**research usage shared with system operations

Figure 2: ISS Post Assembly Complete Payload Accommodations

Module Rack Topology – For Reference Only



Ground Asset For the ISS National Lab
Processing the Space Life Sciences Lab
Biology

SLS Lab Building Information

BUILDING INFORMATION

Total Net Square Feet:	approximately 73,000
Total Gross Square Feet:	approximately 104,000
Building Population:	140 Resident & 38 Visitors
Laboratory Space:	25 science laboratories
	8 hardware laboratories
	6 animal holding rooms

Lab Capabilities Summary

Controlled Environment Lab	15 Controlled Environment Chambers (CEC)
Applied Genetics Technology Lab	Genetic Identification, Quantification & Qualification
Analytical Chemistry	Organic/Inorganic
Animal Care Facility	Rodent/Aquatic/Avian/Insect
Experiment Processing Support	Shuttle/Station/Unmanned
Flight Experiment Development	Design/Testing/Integration
Astrobiology	UF/FIT Science Programs
Biological Imaging	Atomic Level Visualization
Applied Chemistry*	In-Situ Resource Utilization, Environmental Remediation, Corrosion Detection & Coatings, Polymer & Smart Materials
Applied Physics*	Granular & Surface Systems
Electrostatics*	Dust Characterization & Remediation, Surface Physics

(*relocating from O&C to SLS Lab in FY07)

Unique Agency Capabilities

Animal Care Facility (ACF)

- Provides animal husbandry & support for space flight missions
- Skills, equipment and labs unique to pre/post mission support requirements at launch site of life science & biological payloads
- Meets all necessary Agency & Federal cert/license requirements

Biological Payloads Processing Support

- Skills, equipment and labs unique to pre/post mission support requirements at launch site of life science & biological payloads
- Additional unique required support provided by analytical & biomolecular chemistry labs

Controlled Environment Lab (CEL)

- Skills and infrastructure uniquely developed originally for biological sustainable systems (i.e. bio-regenerative life support systems), now serving multi-discipline investigations
- Orbit Environment Simulators for science 'control' of STS/ISS pressurized environment payloads (temp, humidity, CO2, lighting)

Ground Asset For the ISS National Lab
Space Station Processing Facility
Physical Science and Engineering

SSPF Processing Capabilities

Testing Capabilities

- Capability to test sub-rack payloads in a flight certified Express Rack
- Future capability to test sub pallet payloads (un-pressurized) that would be mounted on a truss location or Express Logistics Carrier

Payload Rack Checkout Unit Capabilities

Electrical Power - 120 VDC Programmable Electrical Power Supply Emulator (PEPSE) Local control; Output Current, Output Voltage, Slew Rate, Current Limit settings/ measurements; Emulates U.S. Lab Remote Power Control Modules (RPCMs) Impedance Analysis Assembly (IAA) In-Rush Current Analysis, typically < 10us; Impedance Graphic Representation from 1 Hz to 1 MHz

Command and Data Handling - Low, Medium and High Rate data emulation; PL MDM; PCS; C&C MDM simulator; Payload Ethernet Hub Gateway simulations; command tables

Internal Thermal Control System - Provides cooling to the Express rack

Impedance Analysis

Vacuum

Gas

Internal Video Rack

Express rack checkout area

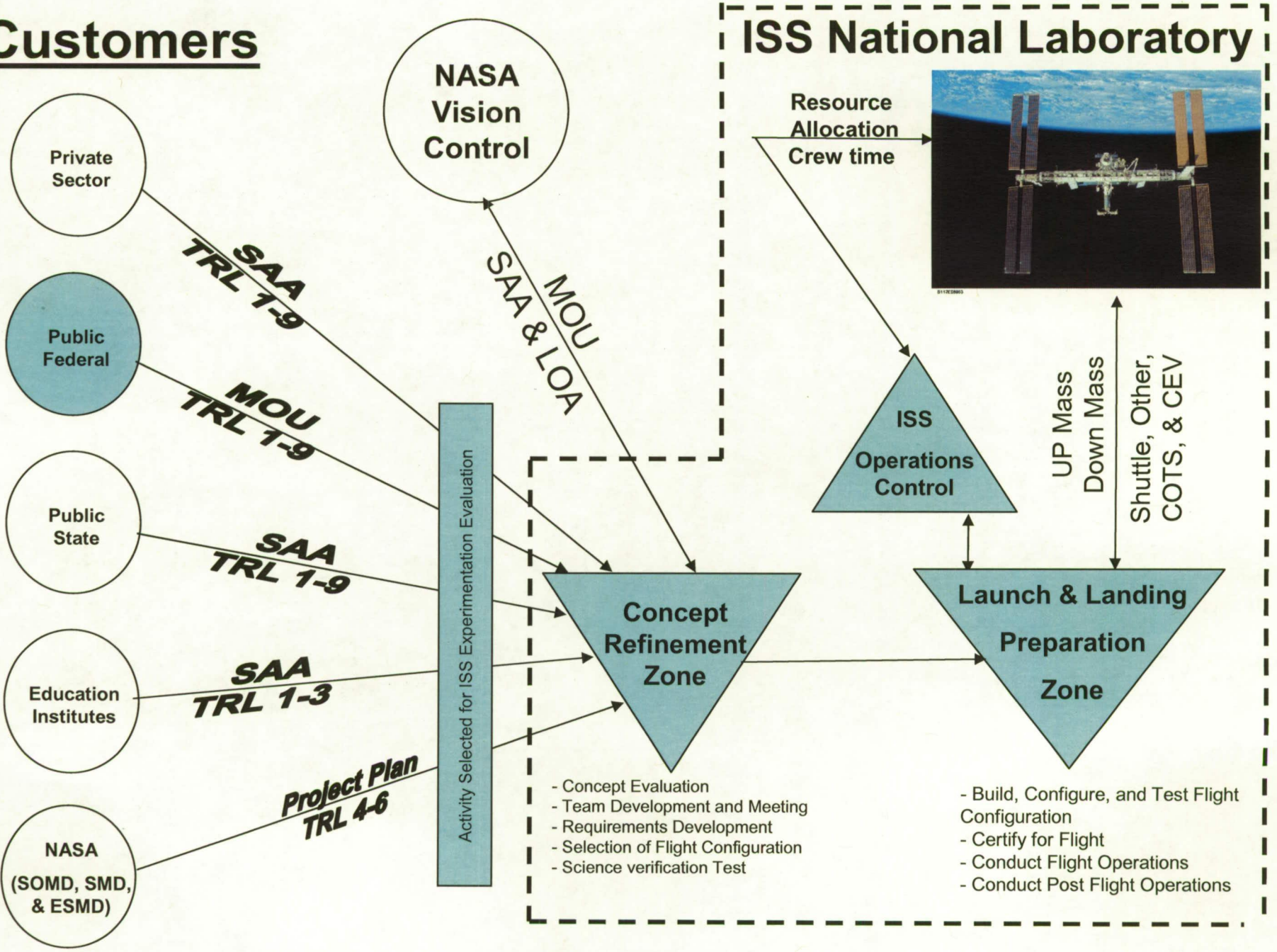
Lab Capabilities Summary

Two 300K Class Labs

120/208 VAC, 60 Hz
various amperage available
Sink (hot and cold water)
Grounding plates
Fluids (tube banks)
Gases (tube banks)
Transportation

Some off-line processing area equipment:
scales, oscilloscopes, metering equipment, temperature & humidity monitors, incubators, ovens, Laminar Flow Benches, etc.

Customers


NASA Vision Control
ISS National Laboratory
Resource Allocation Crew time
Private Sector
Public Federal
Public State
Education Institutes
NASA (SOMD, SMD, & ESMD)
SAA TRL 1-9
MOU TRL 1-9
SAA TRL 1-9
SAA TRL 1-3
Project Plan TRL 4-6
MOU SAA & LOA
Activity Selected for ISS Experimentation Evaluation
ISS Operations Control
UP Mass
Down Mass
Shuttle, Other, COTS, & CEV
Concept Refinement Zone
Launch & Landing Preparation Zone
- Concept Evaluation
- Team Development and Meeting
- Requirements Development
- Selection of Flight Configuration
- Science verification Test
- Build, Configure, and Test Flight Configuration
- Certify for Flight
- Conduct Flight Operations
- Conduct Post Flight Operations

Element is ISS National Laboratory Usage

- Launch and Landing Execution (Non NASA Provider)
- Manifesting Process Execution (National Lab Organization)

- ISS National Lab User develops experiment unique equipment
  - Available Customer Support
    - Flight Hardware Inventory
    - Flight Expertise (Science and Engineering)
    - Training for PI's
    - Experiment Concept Development
    - Flight Requirements Development
    - Rapid proto typing and payload development
      - Hardware Development
      - Software Development
    - Experiment Monitoring and Control

- Time Line normally 2 years

NIH MOU

- This Memorandum of Understanding (MOU) sets forth a framework of cooperation between the National Institutes of Health (NIH) and the National Aeronautics and Space Administration (NASA) to encourage:
  - Communication and interaction between the NIH and NASA research communities to facilitate space-related research and to integrate results from that research into an improved understanding of human physiology and human health.
  - Exchange ideas, information, and data arising from their respective research efforts.
  - Development of biomedical research approaches and clinical technologies for use on Earth and in space.
  - Research in Earth- and space-based facilities that could improve human health on Earth and in space.

NIH MOU

- Of particular interest is the application of the United States (U.S.) portion of the International Space Station (ISS) as a national laboratory, as established by P.L. 109-155. The designation as a National Laboratory underscores the significance and importance that the U.S. places on the scientific potential of the ISS for research in areas including, but not limited to:
  - Basic biological and behavioral mechanisms in the absence of gravity.
  - Human physiology and metabolism.
  - Spatial orientation and cognition.
  - Cell repair processes and tissue regeneration.
  - Pathogen infectivity and host immunity.
  - Medical countermeasures.
  - Health care delivery and health monitoring technologies.

NIH MOU

- Each agency has existing programs and resources for facilitating health research and technology development. Research facilitated by this MOU will be complementary to studies supported by the NIH, its Institutes and Centers, and NASA, at the agencies' intramural or extramural laboratories. In pursuing objectives through this MOU, the NIH and NASA shall handle their own activities and use their own resources, including the expenditure of their own funds unless otherwise agreed in specific implementing agreements.

Key Issues From ARC Meeting

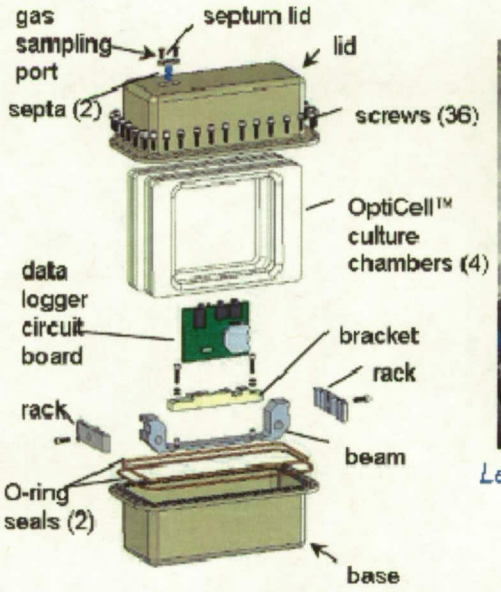
- Access and return
  - We need a shipping agent
- Process
- Partners
- Defining customer needs

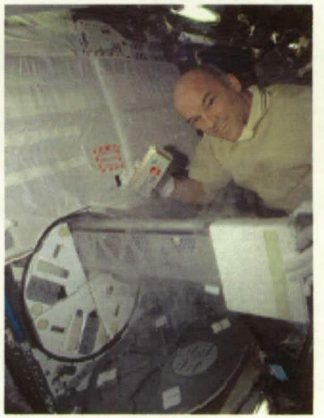
POEMS (Passive Observatories for Experimental Microbial Systems)

PI: Dr. Michael J. Roberts, Dynamac Corporation

Objectives:

- **Describe the multi-generation growth and evolution of a model bacterium, *Bacillus subtilis*, in the space environment.**
- **Demonstrate a passive cultivation environment for microbial research and biological technology development in the spaceflight environment.**





Left: POEMS hardware design. Above: ISS Astronaut Jeff Williams inserting POEMS Canister into MELFI.

ISS Resource Requirements

Accommodation (carrier)	**Middeck locker and CTB**
Upmass (kg) **(w/o packing factor)**	**6.0**
Volume (m^3) **(w/o packing factor)**	**0.017**
Power (kw) **(peak)**	**0**
Crew Time (hrs) **(installation/operations)**	**3.5**
Launc/Increment	**ULF1.1/Increments 13&14**

Microbe (Effect of Spaceflight on Microbial Gene Expression and Virulence in S. typhimurium, P. aeruginosa, C. albicans)

PI: Dr. Cheryl Nickerson, Arizona State University

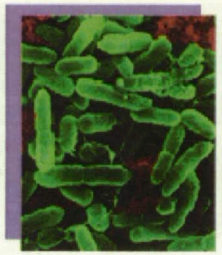
Objective:

- **Assess the effects of spaceflight on gene expressionand virulence potential for 3 microbes: *S. typhimurium, P. aeruginosa,* and *C. albicans by* comparing spaceflight results with ground and modeled microgravity results.**

Publication:

- **PNAS, 9/2007 (Space flight alters bacterial gene expression and virulence and reveals a role for global regulator Hfq. Wilson *et al.*)**
  - Following flight, *S. typhimurium* exhibited enhanced virulence in a rodent infection model.
  - Results suggest genetic targets to provide novel therapeutic options to decrease infections risk during spaceflight or on the Earth.

S. typhimurium



P. aeruginosa

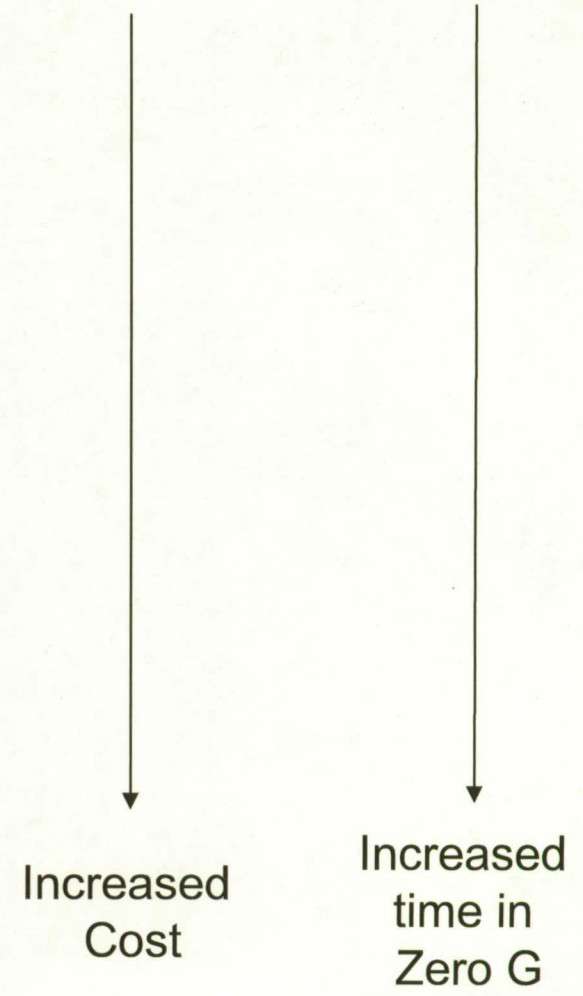
C. albicans

ISS Resource Requirements

Accommodation (carrier)	**Middeck**
Upmass (kg) **(w/o packing factor)**	**12.29**
Volume (m^3) **(w/o packing factor)**	**0.02**
Power (kw) **(peak)**	**0.0**
Crew Time (hrs) **(installation/operations)**	**2.0**
Launch/Increment	**12A/Increment 13**

Investigation Progression

- Drop Tower testing
- Parabolic flight
- Sub-orbital flight
- Highly elliptical flight
- Orbital sorties
- Visits to ISS



Where From Here

- Define research areas of interest to DOE
- Create a MOU between NASA and DOE to define participation in the ISS National Lab
- Begin preparation at DOE for 2011-2012 ISS National Lab experiments